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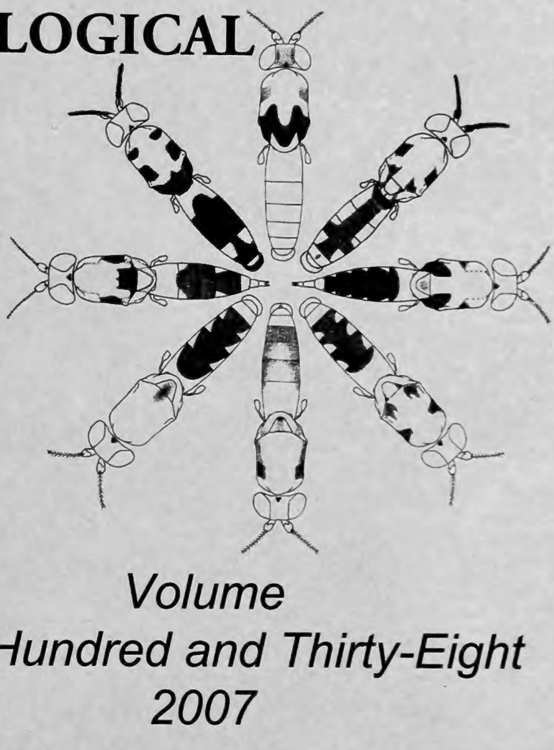

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One Hundred and Thirty-Eight
2007

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1863

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2006-2007

*Please submit manuscripts electronically to the Editor (miriam.richards@brocku.ca).

JOURNAL
of the
ENTOMOLOGICAL SOCIETY OF ONTARIO

VOLUME 138 *2007*

You will notice that there are two Editors' Forwards in this volume of the Journal of the Entomological Society of Ontario. On page 2 is the forward from Special Editor Steve Marshall that was originally printed in Volume 137, which I have been thinking of as 'Pengelly I', with the first five papers in this volume comprising 'Pengelly II'. About two years ago, we began planning a special volume in memory of David Pengelly, an entomologist at the University of Guelph who inspired many Ontario and Canadian entomologists. It is a mark of the esteem in which his students and colleagues held him, that the memorial volume had to be split into two. I would like to express my warmest thanks and appreciate to Steve Marshall who acted as the Special Editor of the Pengelly volumes.

With the publication of Volume 138, I am delighted to note that JESO has resumed a timely publication schedule. Not only is the 2007 volume actually being published in 2007, but preparations are already underway for Volume 139, to be published in 2008. Another important change is electronic distribution of published manuscripts, with the added attraction that the electronic versions may include colour plates and maps, which are generally impossibly expensive to print. Electronic distribution will enable our authors' work to reach the wider audience that it deserves, not least of all because it will become accessible to web search engines. These are important developments in bringing JESO to a wider audience, and everyone who has helped to get us to this point, should award herself or himself a pat or two on the back. I especially thank the JESO Editorial Board, the ESO Board, our patient Technical Editor, and the many reviewers whose hard work and enthusiasm for the Journal, have been the real impetus for these changes.

After that moment of self-congratulation, let me assure you that we are not resting on our laurels, but intend to continue building on the momentum we have established. First, we are committed to maintaining annual publication in the autumn of each year (dare we dream of bi-annual publication?), so please submit your work to JESO – we are already considering manuscripts for Volume 139 (2008), and the more, the merrier. Remember, all entomological research is welcome, whether its subjects are in Ontario or elsewhere. Second, we are planning to begin converting back volumes of JESO into electronic format for distribution from the website – eventually we would like to post all volumes of JESO and its predecessor, the Proceedings of the ESO, right back to volume 1. Third, the success of these Pengelly volumes has inspired suggestions for future special volumes devoted to particular entomological themes. All these plans will help to ensure a bright and buggy future for the Journal.

Happy reading!

Miriam H. Richards
Editor

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VOLUME 138 *2007*

It has been a pleasure for me to serve as Special Editor for the D. H. Pengelly tribute volumes, and to work with regular Editor Miriam Richards to line up a diverse assemblage of papers touching on the range of entomological disciplines influenced by Dave Pengelly (1922-2004). Dave was widely known, and is fondly remembered, as a fantastic teacher of entomology and as a huge contributor to the development of the University of Guelph Insect Collection; but he is also sorely missed as a seemingly infinite reservoir of entomological trivia, anecdotes, insightful stories, jokes, support, and wise advice. Almost all of the authors in these volumes were strongly influenced by Professor Pengelly, most shared his enthusiasm and passion for collecting and identifying insects, and many worked with Dave to build up the University of Guelph Insect Collection. Although now widely appreciated as a treasure trove of information about faunal change and insect distribution while also serving as the foundation for a growing body of taxonomic research, the University of Guelph Insect Collection during Pengelly's tenure was a beleaguered resource used mostly as a source of specimens for a myriad of entomology courses including the hands-on third year entomology labs that Dave taught every weekday. It is a testimonial to his foresight that he not only kept the collection from deterioration or destruction due to invasions of dermestid beetles and indiscriminate colleagues, he consistently built up the collection and increased its curatorial level annually. He did not do this alone, of course. Professor Pengelly had a contagious vision of what was needed to improve our understanding of Ontario's insects, and his enthusiasm for the study of insect biology and diversity was such that he was always associated with dedicated students. Thousands of specimen labels in the insect collection bear the names of most of the authors of papers in these volumes, standing as permanent testimonials to a shared vision that started with students working with their mentor at University of Guelph, and which continues through the widely dispersed teaching, research, and publications by Dave's students and colleagues today. I think he would have liked these sets of papers, and he would have been pleased to see them published in the journal that he supported so selflessly … almost every copy of this journal sent out during the 16 year period "D.H." was Secretary-Treasurer of the ESO was sent out by Dave personally. We all wish he were still here to send this one out!

Steve Marshall
Special Editor

REVIEW OF *EUSTOCHUS*, A RARELY COLLECTED GENUS OF MYMARIDAE (HYMENOPTERA)

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Canadian Forestry Service, Natural Resources Canada

Abstract *J. ent. Soc. Ont.* 138: 3–31

The four nominal species of *Eustochus* are reviewed. Four new species, *E. confusus* from Spain, *E. pengellyi* and *E. yoshimotoi* from North America, and *E. nipponicus* from Japan are described and a key to the eight species is given.

Résumé
Nous revisons les quatre espèces nominales d'*Eustochus*. Nous décrivons quatre nouvelles espèces, *E. confusus* d'Espagne, *E. pengellyi* et *E. yoshimotoi* d'Amérique du Nord, et *E. nipponicus* du Japon, et pourvoyons une clé d'identification aux huit espèces.

Published November 2007

Introduction

The Holarctic genus *Eustochus* was established by Haliday (1833) for a species described by Curtis (1832) in a key as a species of *Mymar–M. atripennis* (which he attributed to Walker). Curtis's laconic description, abstracted here from his key, reads: 'abdomen petiolated, wings ciliated and perfect, ovipositor exserted, longer than the abdomen'. The collection information given next to the name *atripennis* states simply 'June, amongst grass in a wood'. Graham (1982) suggested that perhaps only one specimen had been collected by Walker, probably at or near Southgate, Middlesex (England). Haliday (1833) redescribed *E. atripennis* (Curtis) in more detail, and included it as the only species within his new genus *Eustochus*. He mentioned that the species occurred 'in autumn, among trees, but very rare'. Since then, the genus has been mentioned infrequently in the literature and only three more species have been described, based on very few specimens each. Here, we review the described species and describe four new ones from Spain, Canada, USA, and Japan.

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Materials and Methods

This study is based on recent examination of about 115 specimens from the institutions listed below.

Eustochus species all appear to be very similar to one another so long descriptions for each species, as for *E. besucheti* Bakkendorf, would be repetitious; therefore, diagnoses only are given. The new species are described and illustrated based on females because males are known for only two species and are exceedingly rare (7 specimens known). Specimens from Japan were dissected and gold coated for the scanning electron micrographs (Figs. 1 –15).

Morphological terms used follow Gibson (1997). Measurements, from slide-mounted specimens unless otherwise indicated, are given in micrometers (µm), and are as described in Huber (1987). The range is followed by the number of specimens measured, in parentheses. Primary type data is recorded as found on each label, with slashes indicating the beginning of each new line. Data from other specimens is given in a standardized format to simplify retrieval or comparison. Abbreviations used are: Fl_1–Fl_6=funicle segment one to six, FWL or FWW=forewing length or forewing width, Fl_x L (W)=flagellar segment length (width).

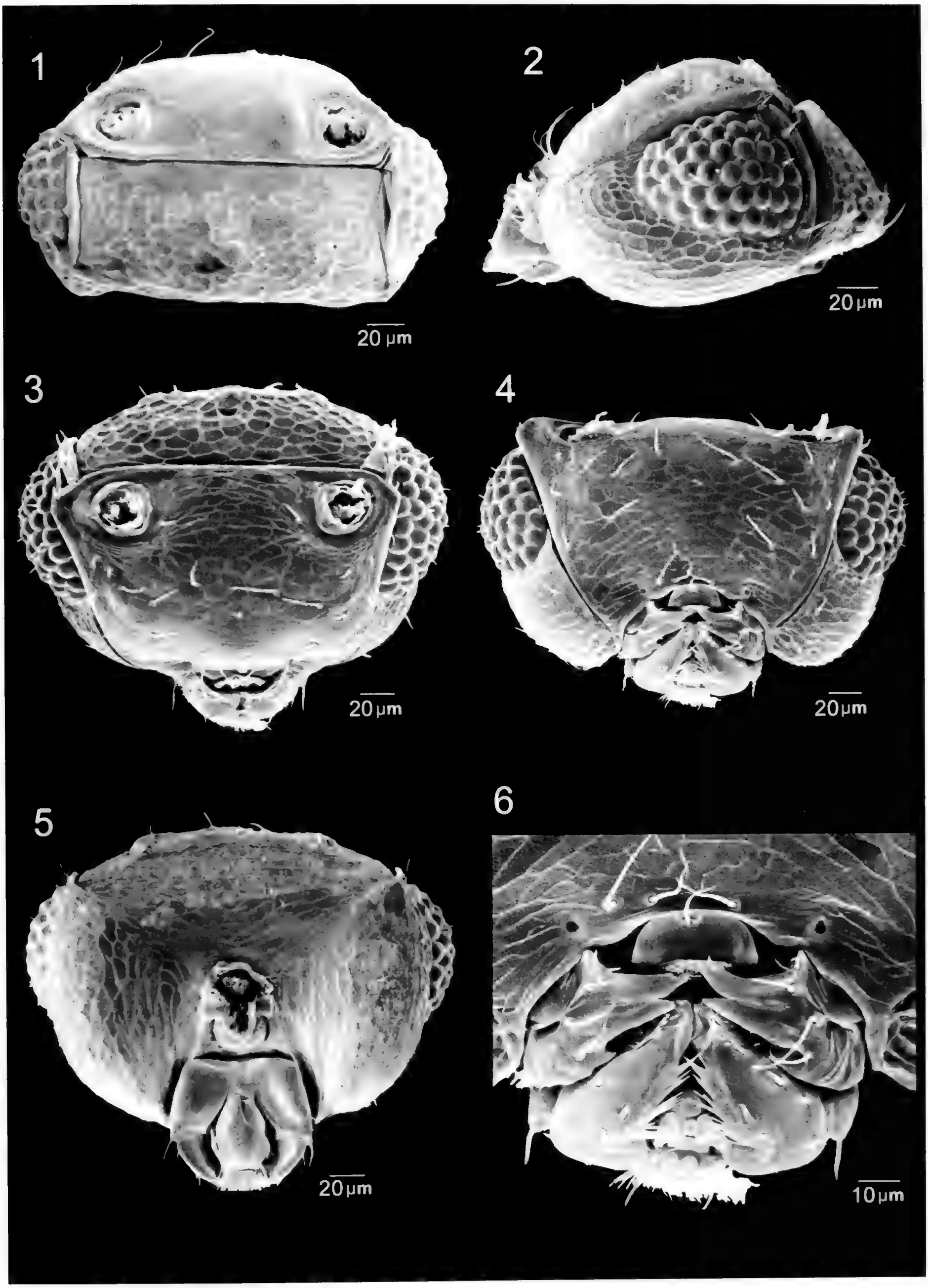
Acronyms of repositories: CNC–Canadian National Collection of Insects, Ottawa, Canada, J. Huber; FAFU–Biological Control Research Institute, Fujian Agricultural and Forestry University, Fuzhou, China, N.-Q. Lin; MRSN–Museo Regionale di Scienze Naturali (Spinola Collection), Turin, Italy, G. Pagliano; MZNA–Museo de Zoología, Universidad de Navarra, Pamplona, Spain, E. Baquero; MHNG–Museum d'Histoire Naturelle, Geneva, Switzerland, C. Besuchet; UCRC–University of California, Riverside, CA, USA, S. Triapitsyn; USNM–National Museum of Natural History, Washington, DC, USA, M. Gates.

Eustochus Haliday

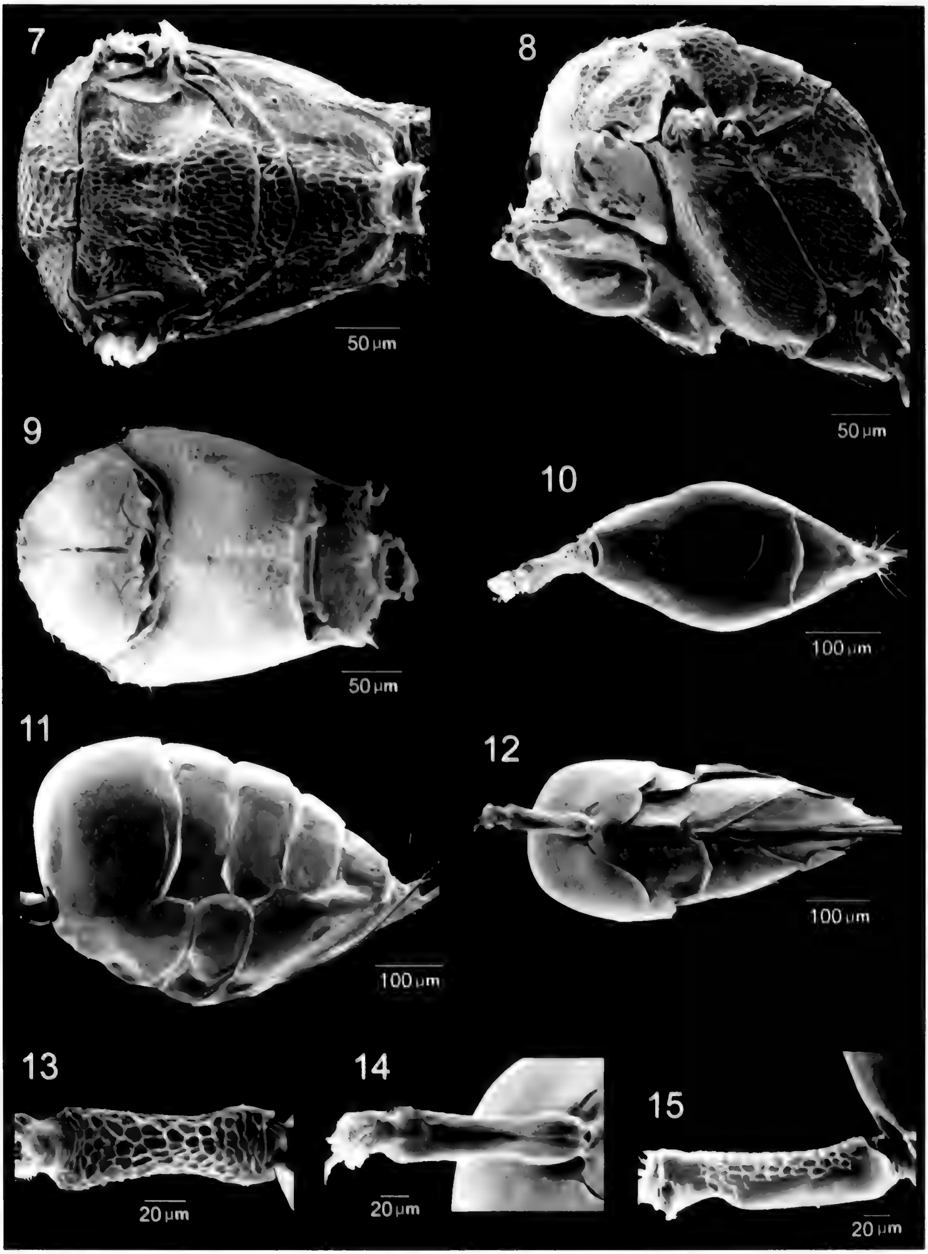
Eustochus Haliday, 1833: 269 (key), 349 (description); Westwood, 1839: 78 (diagnosis); Walker, 1846: 50 (diagnosis); Foerster, 1847: 225 (diagnosis); Foerster, 1856: 117 (key); Blanchard, 1840: 293 (diagnosis); Dalla Torre, 1898: 428 (catalogue); Ashmead, 1904: 363 (key); Schmiedeknecht, 1909: 494 (key), 495 (diagnosis); Gahan and Fagan, 1923: 64 (type species designation); Schmiedeknecht, 1930: 450 (key); Kryger, 1950: 61 (description); Annecke and Doutt, 1961: 24 (generic comment); Debauche, 1948: 200 (description); Schauff, 1984: 50 (diagnosis, phylogeny); Yoshimoto, 1990: 57 (diagnosis); Xu and Lin, 2003: 65 (diagnosis).

Type species: *Mymar atripennis* Curtis, by monotypy.

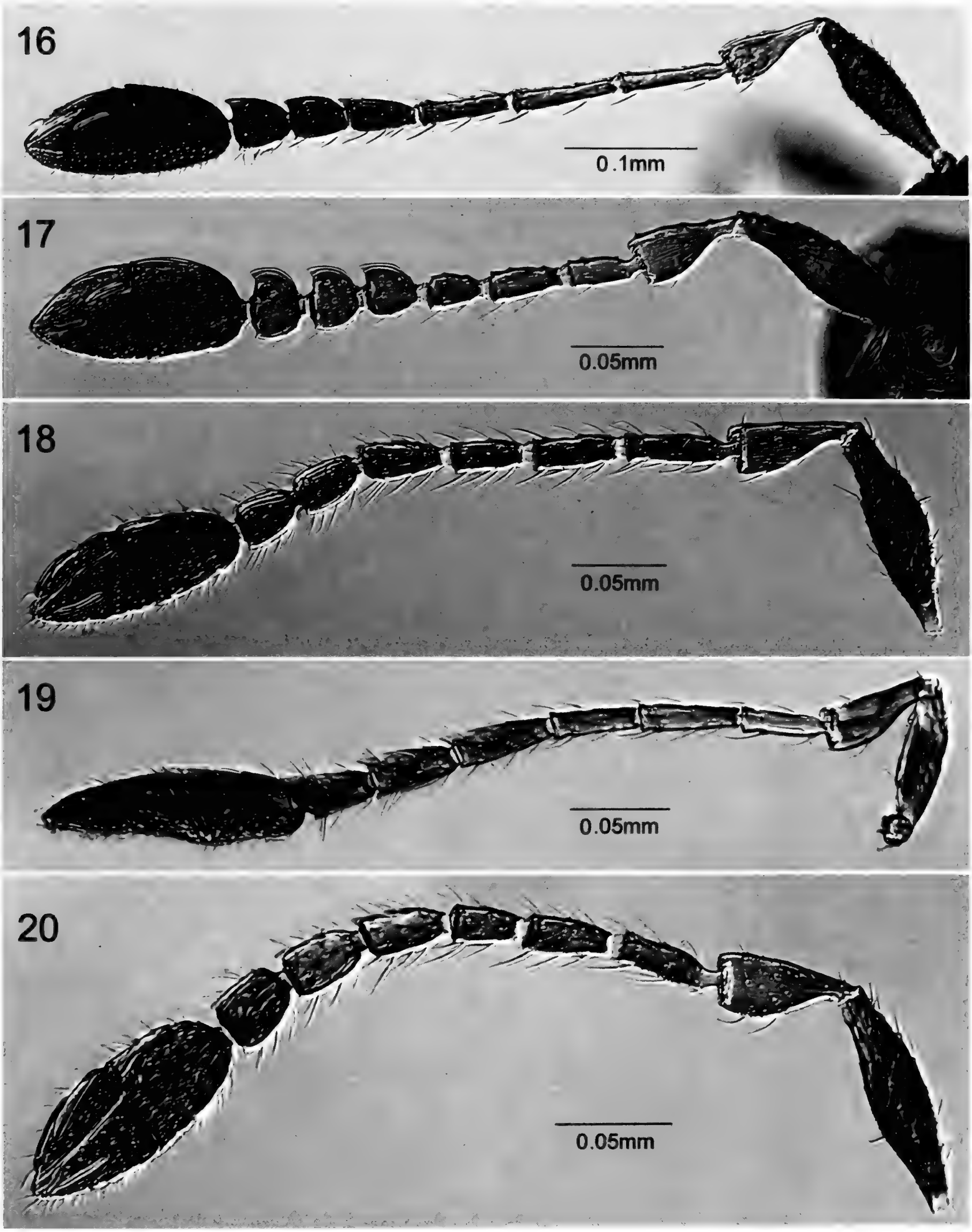
Diagnosis. Body 670-1330 µm in length (critical point or air dried specimens); brown to dark brown, with appendages somewhat lighter in colour. Head (except face) and mesosoma, scape, dorsal surface of gastral petiole, coxae and femora with distinct reticulate sculpture (Figs. 1–5, 7–10, 13, 15, 35, 36, 38–43); gaster, underside of petiole, and remainder of legs



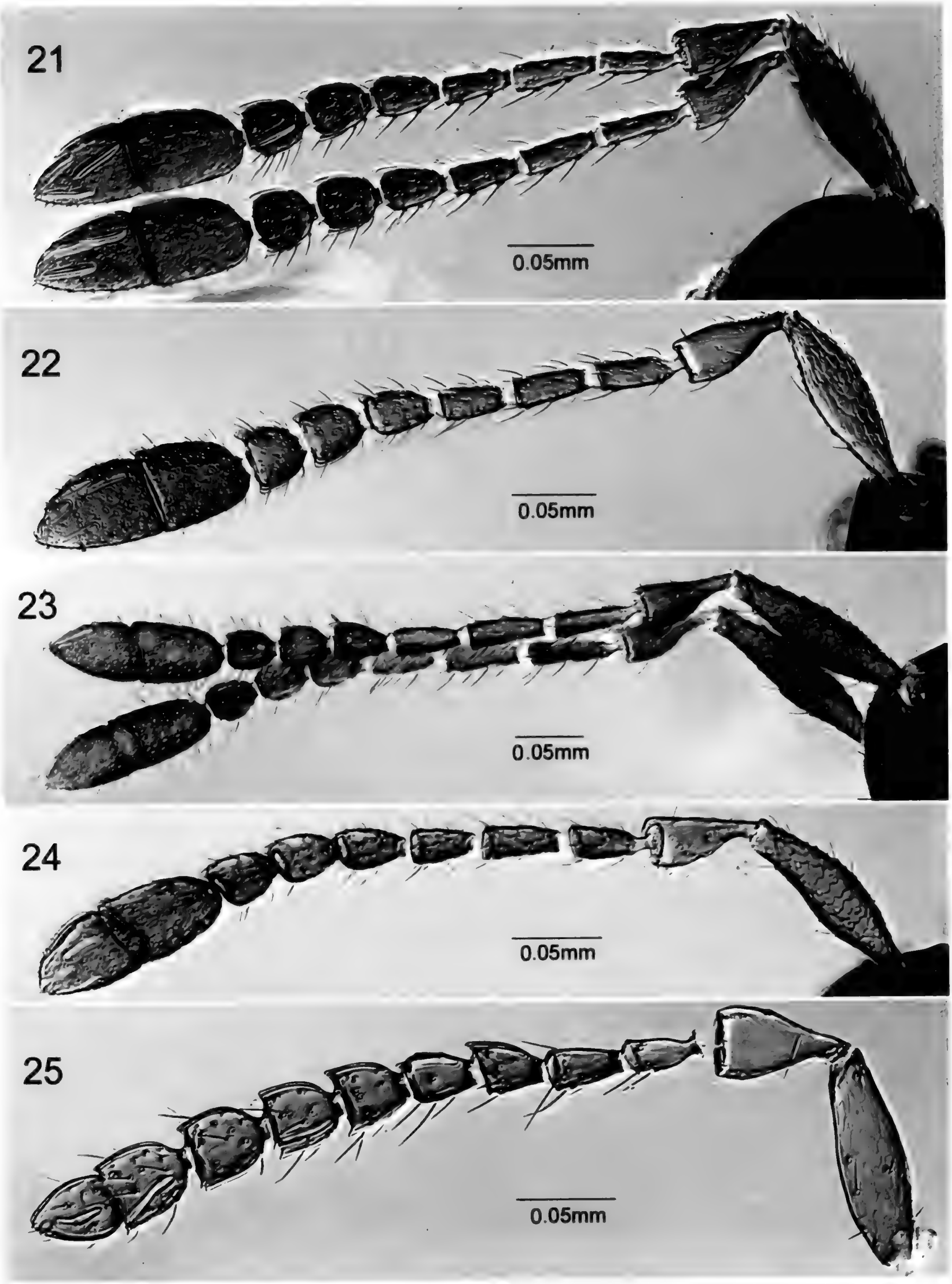
FIGURES 1–6. Head, *Eustochus* sp. probably *atripennis* (Japan, Mt. Tsukuba). 1–dorsal; 2–lateral 3–anterior; 4–ventral; 5–posterior; 6–mouthparts.



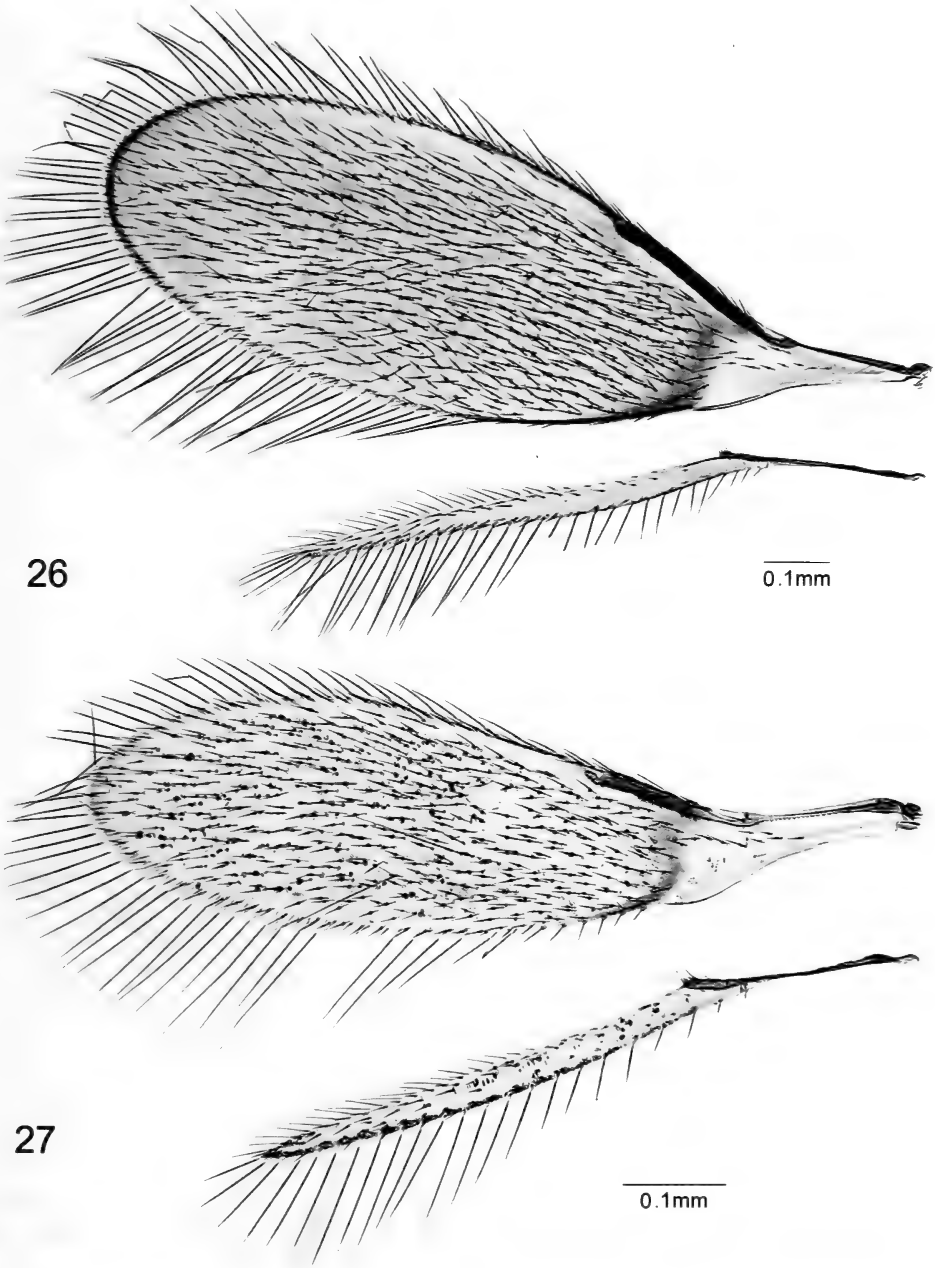
FIGURES 7–15. Mesosoma and metasoma, *Eustochus* sp. probably *atripennis* (Japan, Mt. Tsukuba). 7–mesosoma, dorsal; 8–mesosoma lateral; 9–mesosoma ventral; 10–metasoma, dorsal; 11–metasoma, lateral; 12–metasoma, ventral; 13–petiole dorsal; 14–petiole, ventral; 15–petiole, lateral.



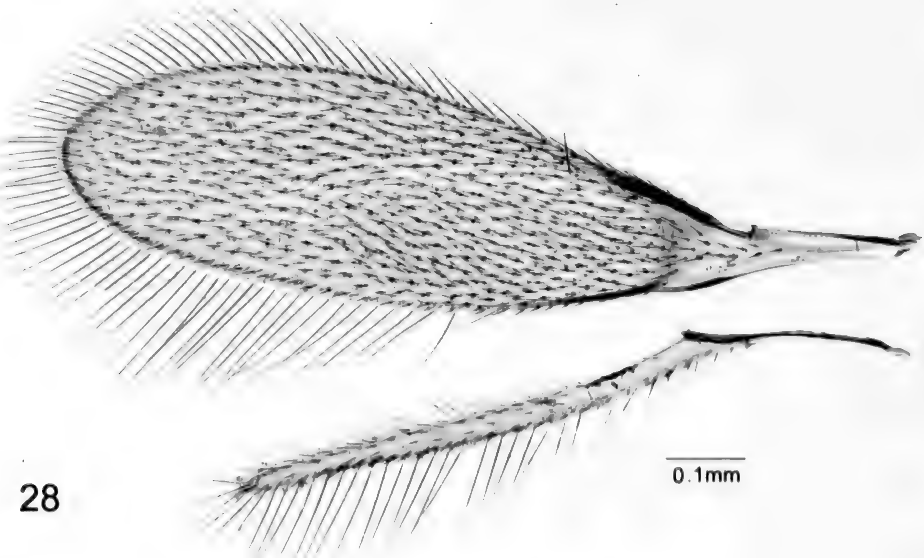
FIGURES 16–20. *Eustochus* spp., female antenna, lateral. 16–*atripennis* (Germany, Bornheim); 17–*besucheti* (Switzerland, Laquintal); 18–*nearcticus* (Canada, MacKenzies Mt.); 19–*triclavatus* (paratype); 20–*pengellyi* (holotype).



FIGURES 21–25. *Eustochus* spp., female antenna (except 25), lateral. 21–*yoshimotoi* (holotype); 22–?*nearcticus* (USA, Andrews Bald); 23–*confusus* (holotype); 24–*nipponensis* (holotype); 25–*atripennis*, male (Switzerland, Chancy).



FIGURES 26–27. *Eustochus* spp., wings. 26–*atripennis* (Germany, Bornheim); 27–*besucheti* (Switzerland, Laquintal).



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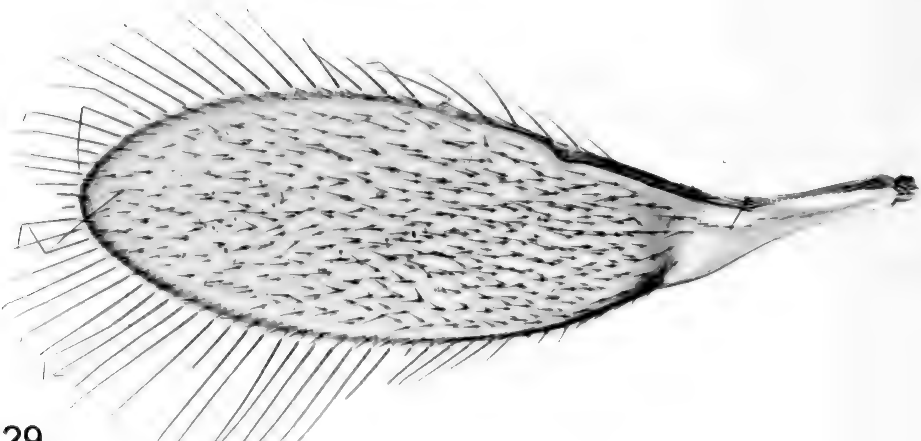

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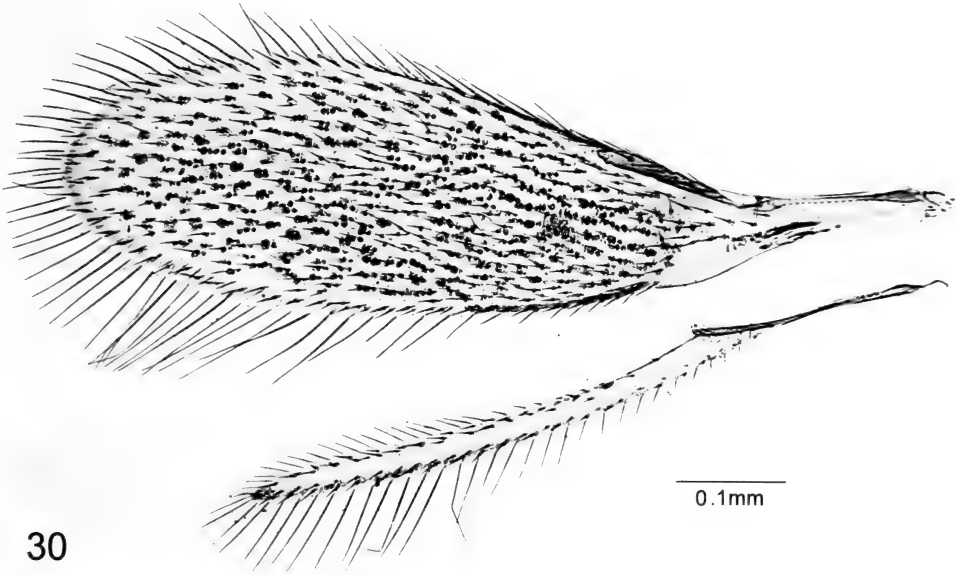
FIGURES 28–29. *Eustochus* spp., wings. 28–*nearcticus* (NS, MacKenzies Mt.); 29–*triclavatus* (paratype).



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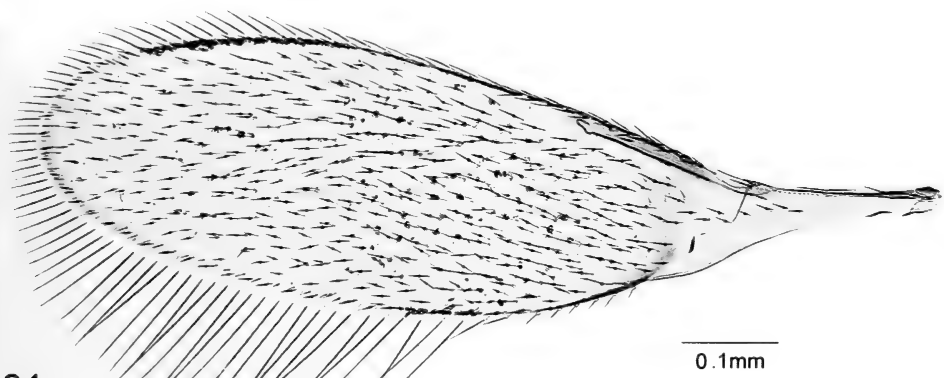

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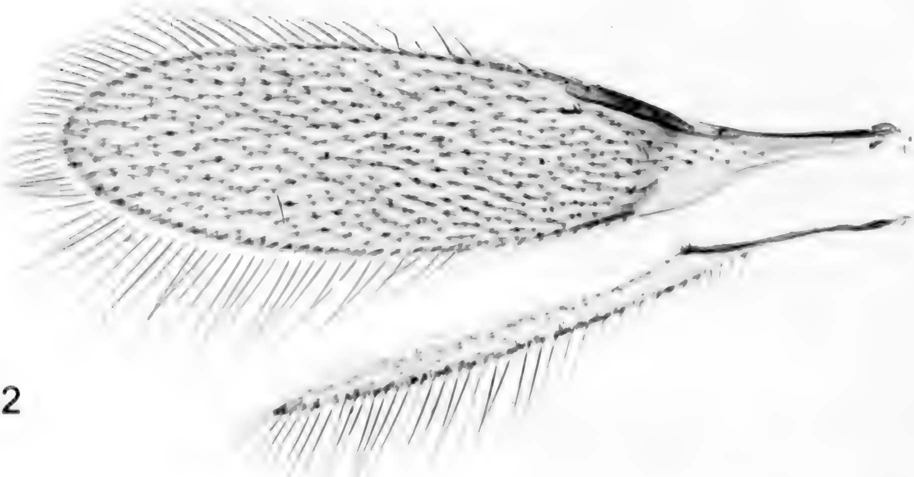
FIGURES 30–31. *Eustochus* spp., wings. 30–*pengellyi* (holotype); 31–*yoshimotoi* (holotype).



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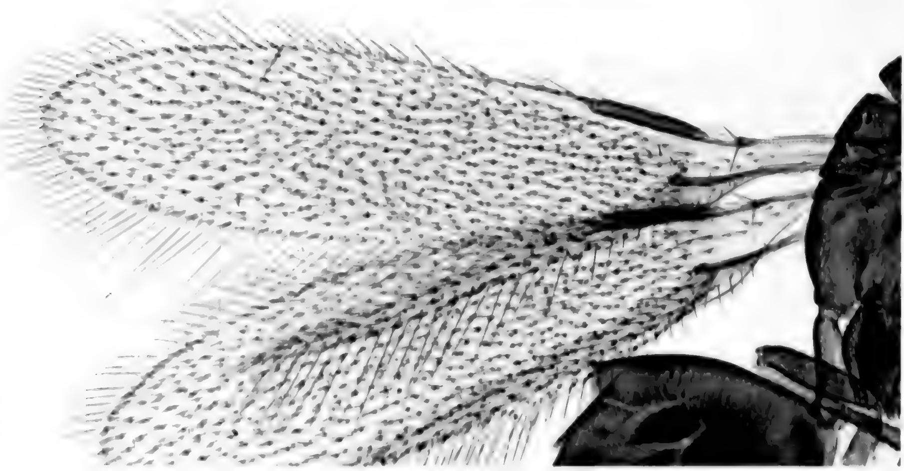

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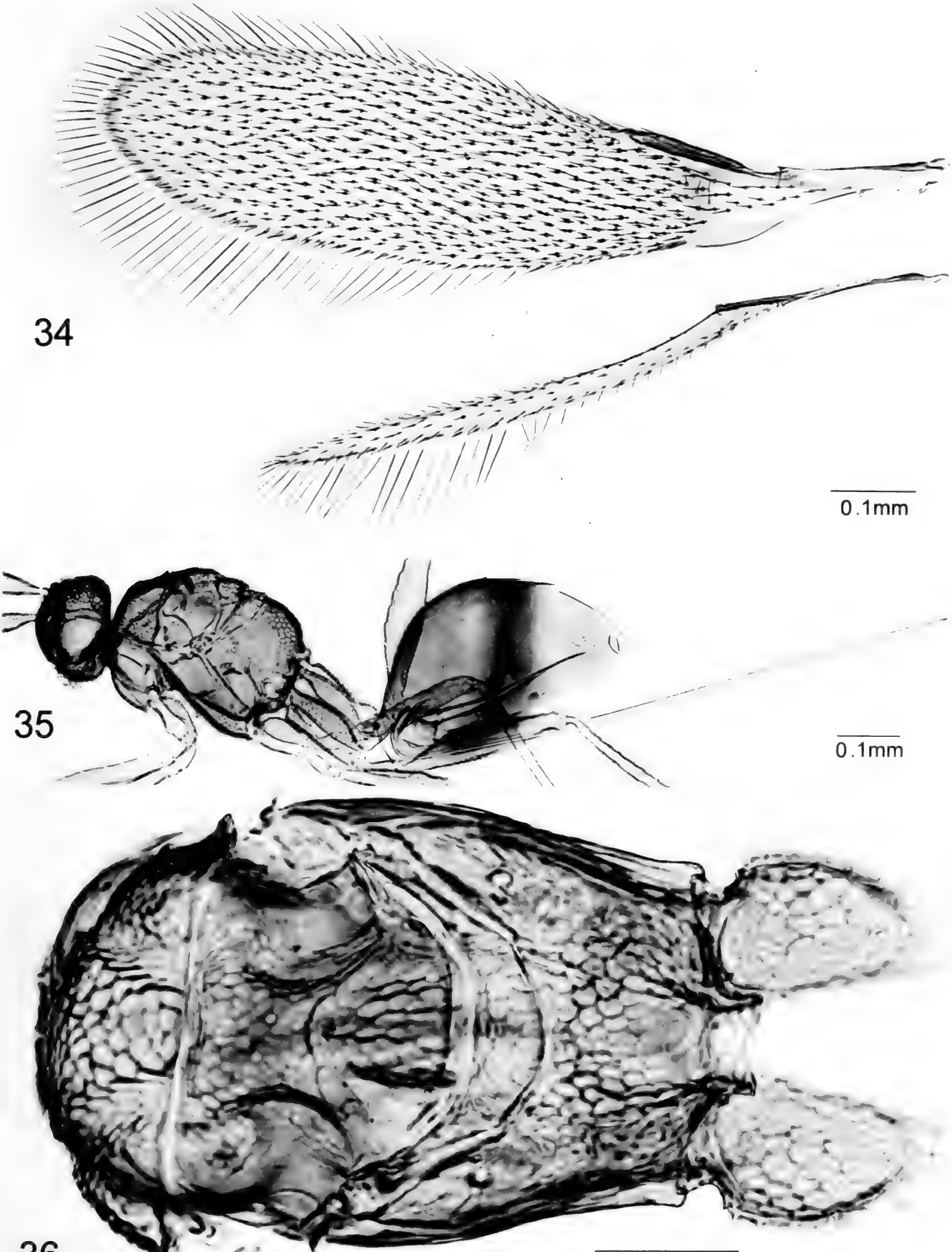
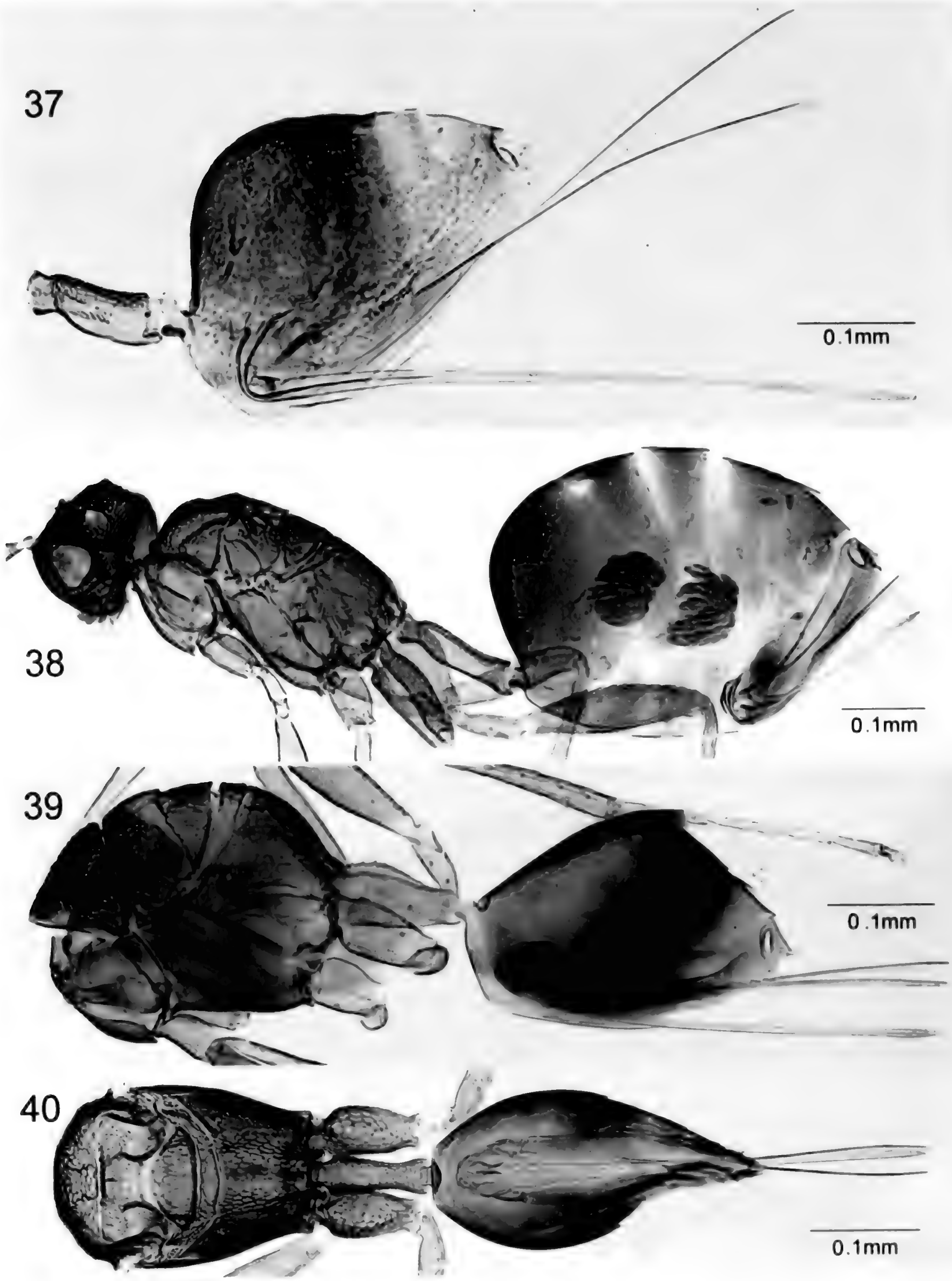
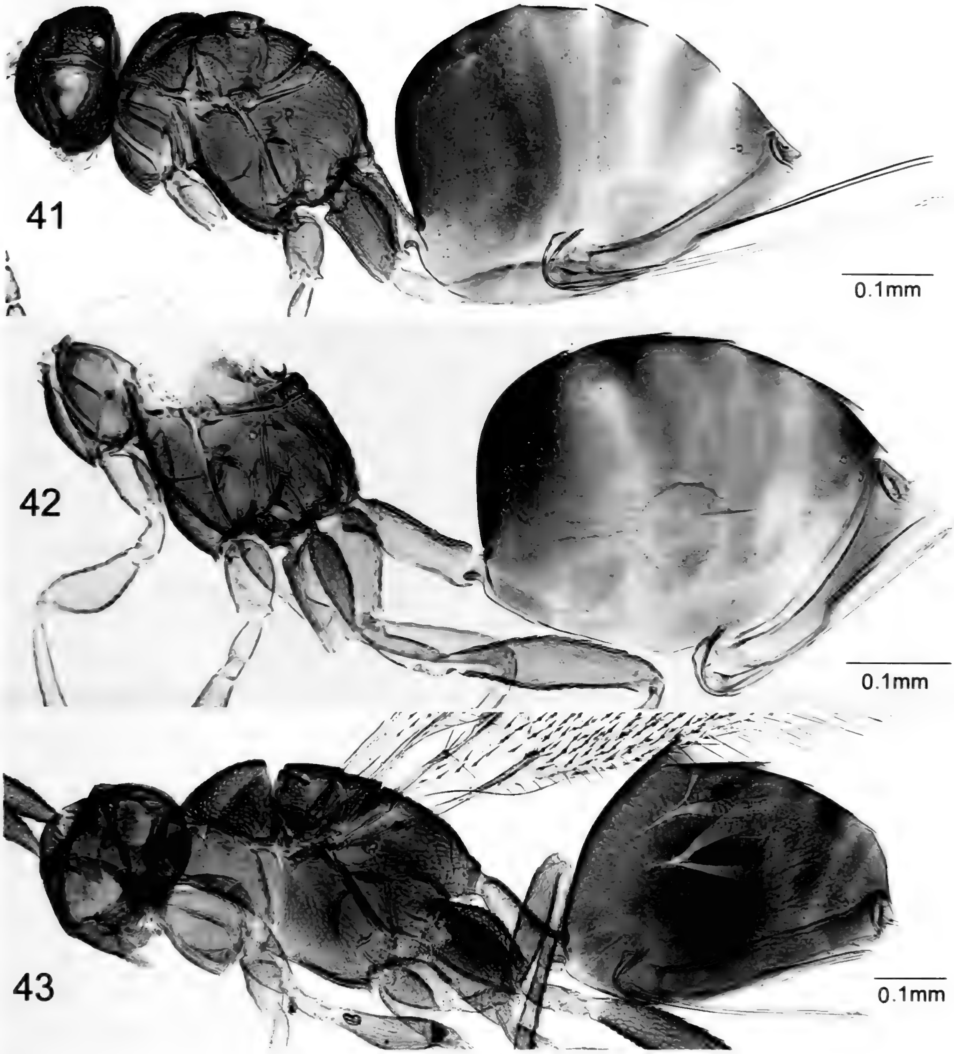
FIGURES 32–33. *Eustochus* spp., wings. 32–?*nearcticus* (USA, Andrews Bald); 33–*confusus* (holotype).



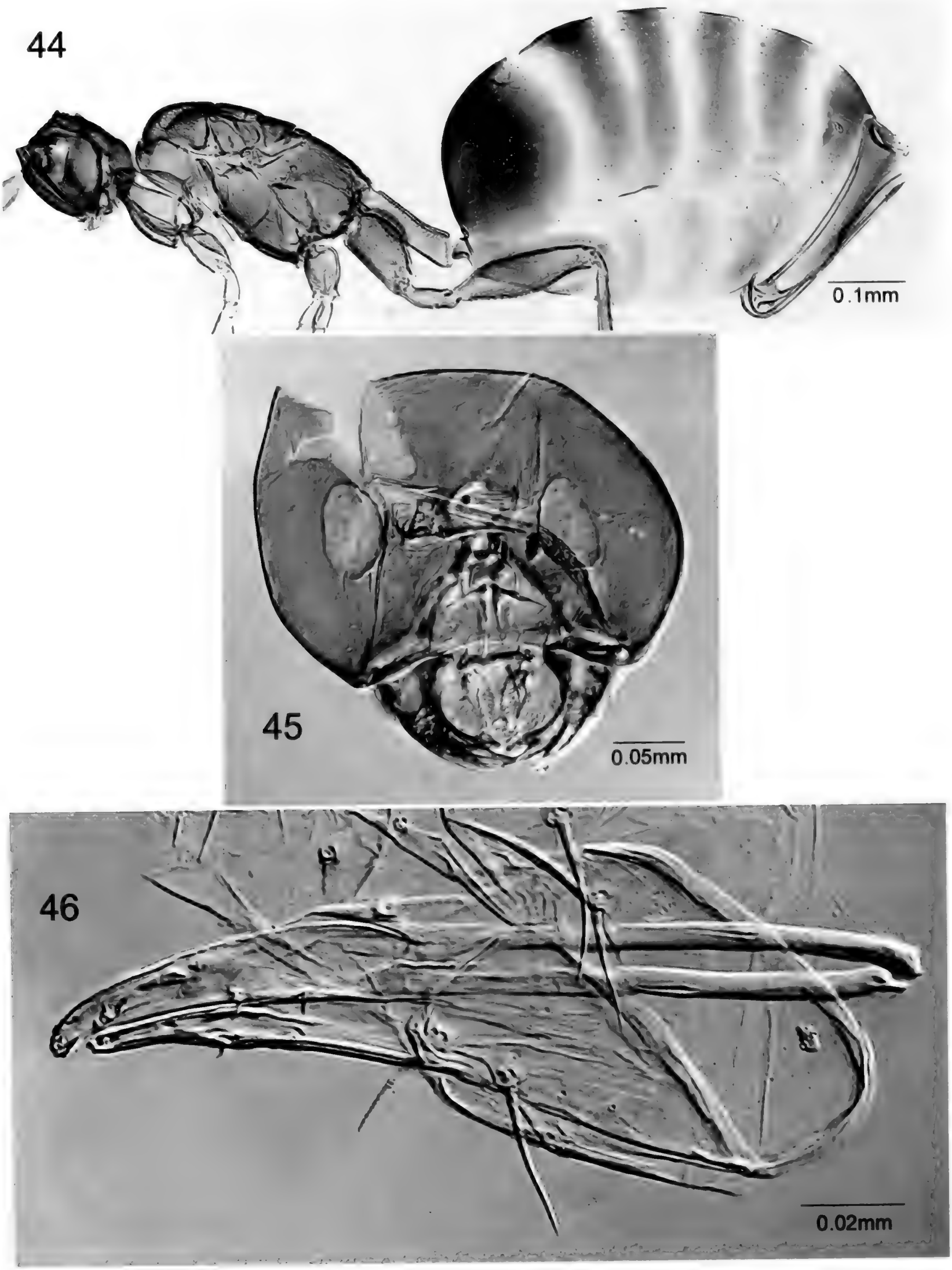
FIGURES 34–36. *Eustochus* spp., wings and bodies. 34–*nipponicus*, wings (holotype); 35–*atripennis,* body lateral (Germany, Bornheim); 36–*besucheti,* mesosoma dorsal (Switzerland, Laquintal).



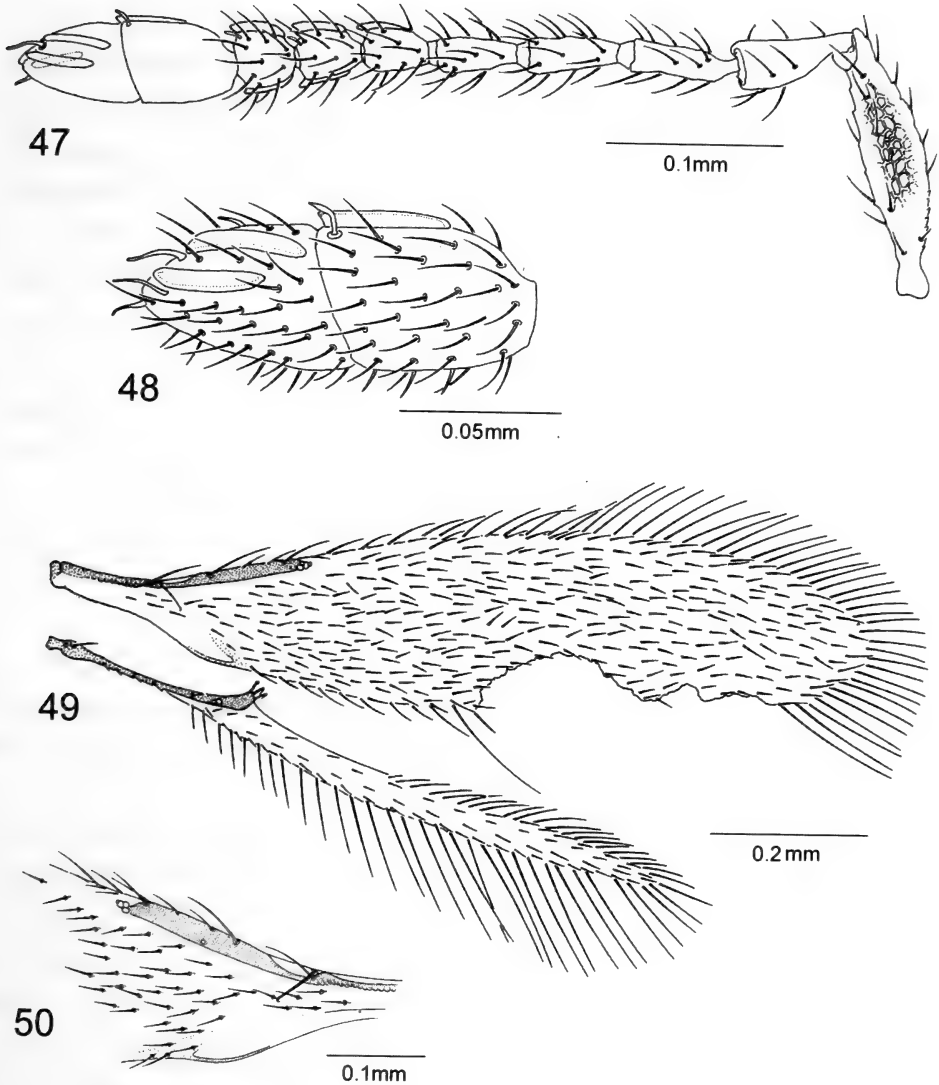
FIGURES 37–40. *Eustochus* spp., bodies. 37–*besucheti*, metasoma lateral (Switzerland, Laquintal), 38–*nearcticus*, lateral (NS, MacKenzies Mt.); 39–*triclavatus*, mesosoma + metasoma, lateral (paratype); 40–*pengellyi*, mesosoma + metasoma, dorsal (holotype).



FIGURES 41–43. *Eustochus* spp., bodies. 41–*yoshimotoi*, lateral (holotype); 42–*?nearcticus*, mesosoma + metasoma, lateral (USA, Andrews Bald); 43–*confusus*, lateral (holotype).



FIGURES 44–46. *Eustochus* spp. 44–*nipponensis*, body lateral (holotype); 45–*atripennis*, male head, anterior (Switzerland, Chancy); 46–*atripennis*, male genitalia, ventrolateral.



FIGURES 47–50. *Eustochus confusus* (paratype). 47–antenna; 48–clava; 49–wings (forewing damaged); 50–forewing venation.

smooth (Figs. 10–12, 14). Legs with 4 tarsal segments, the basal one not much longer than each of the others.

Female. Eyes of normal size but ocelli small, the posterior ocelli not much larger than the mesh diameter of surrounding scupture (Figs. 1–3). Mandibles either relatively short and not quite meeting medially or occasionally slightly overlapping medially, with two (Fig. 6) or, usually, three teeth. Antennal funicle 6-segmented and clava 2-segmented (Figs. 16–18, 20–24) or, rarely, 3-segmented (Fig. 19); flagellum with longitudinal sensilla on fl_4 (1 sensillum), fl_5 (2 sensilla), fl_6 (2 sensilla) and clava (1 sensillum on basal segment, 5 on apical segment) [distribution of longitudinal sensilla on clava of *E. triclavatus* not clear due to collapse and poor orientation]. Forewing oval, with a more or less distinct, comma-shaped, dark mark extending from basal half of marginal vein to posterior margin just beyond retinaculum (Figs. 26–34); venation 0.35-0.4 times length of forewing; marginal + stigmal vein longer than submarginal vein; hypochaeta directly in front of proximal macrochaeta or slightly basal to it and two, widely separated, distal macrochaetae present, the second distal macrochaeta near apex of venation near base of short stigmal vein. Petiole long and narrow (Figs. 13–15, 38, 40, 42, 44). Gaster smooth, deep, and somewhat compressed, with gt_1 the largest tergum (Figs. 10, 11, 13, 38–44); spiracle present on gt_6; dorsal one or two cercal setae extremely long and curved (Figs. 11, 13), distinctly longer than ventral two setae. Ovipositor either very long and conspicuously exerted beyond gastral apex, or short and not extending beyond gastral apex.

Male. Forewing minute and hindwing absent, with very small eyes and ocelli absent, and large, tridentate mandibles that meet medially (Fig. 45); body with reticulate sculpture less pronounced than in female. Antenna with 9 flagellar segments, the apical two widely joined to form a loose clava (Fig. 25).

Discussion. *Eustochus* is most closely related to *Caraphractus* Walker, another strictly Holarctic genus (Schauff 1984). Members of both genera have strongly sclerotized bodies with distinct reticulation on the head, mesosoma, petiole, coxae, and scape, and they have similar mesosomal, metasomal, and wing structure. Sclerotization, surface sculpture, and wings may be convergent due to the habitats in which the species of both genera are found. A well sclerotized body and strengthened wings are needed for protection while moving around in forest litter (*Eustochus*) or water (*Caraphractus*). The heavy surface sculpture may trap air around the body. A host shift from terrestrial to semiaquatic to aquatic host may have occurred in some ancestral *Eustochus* species, leading to species that are now classified as *Caraphractus*, which parasitize only Dytiscidae, as far as is known. Though hosts for *Eustochus* are unknown, a few specimens of *Eustochus* have been collected near water (see *E. atripennis*, below) and the change from hosts in forest litter or soil to hosts near and eventually in water may easily have occurred.

Biology. Hosts are unknown. Most specimens of *Eustochus* examined were collected from deciduous forests. A few were collected near water, and one specimen of *E. nearcticus* Yoshimoto from Alberta was collected from gravel in water. A few specimens appear to have been collected in more open habitats (heron rookery, edge of cornfield), though it

is not possible to know exactly what microhabitat they were in. Females and the males of *E. atripennis* and *E. besucheti* were collected near the base of an old trunk (Viggiani 1970), from soil under oak (specimen record, below), and from moss (Bakkendorf 1965), respectively. A few were also collected in pitfall or Malaise traps. Label data on many females from Switzerland indicated they were collected from dead leaves and the Belgian specimen (from Forêt de Soignes, Rouge Cloître) described by Debauche (1948) was collected by sifting dead leaves. Most likely, species of *Eustochus* parasitize hosts that lay their eggs in soil, surface litter, or mosses. The number of specimens collected near water suggests an aquatic host. A given species of *Eustochus* likely has more than one generation per year, judging from the range of dates when specimens were collected, e.g., March to September for *E. atripennis*.

Key to *Eustochus* species

Females

1 Ovipositor exerted distinctly beyond apex of gaster, considerably longer than metatibia (Figs. 35, 37, 39, 40) 2

– Ovipositor not exerted beyond apex of gaster, shorter than metatibia (Figs. 38, 42, 43, 44) 6

2(1) Fl_3 3.5 times as long as wide, only slightly shorter than fl_2 (Figs. 16, 19) 3

– Fl_3 at most 2.2 times as long as wide, distinctly shorter than fl_2 (Figs. 17, 20, 21) 4

3(2) Clava 2-segmented; fl_4 2.1 times as long as wide (Fig. 16); forewing with longer venation (distance between second and third macrochaeta at least 1.8 times distance between first and second macrochaeta) .... *E. atripennis* (Curtis)

– Clava 3-segmented; fl_4 2.7 times as long as wide (Fig. 19); forewing with shorter venation (distance between second and third macrochaeta about 1.4 times distance between first and second macrochaeta) .... *E. triclavatus* Xu and Lin

4(2) Fl_4–fl_6 each longer than wide (Figs. 20, 21); Nearctic 5

– Fl_4–fl_6 each as wide as long, quadrate (Fig. 17); European .... *E. besucheti* Bakkendorf

5(4) Forewing (Fig. 31) with distinct triangular asetose area behind venation (between level of hypochaeta and first distal macrochaeta) and in front of one and a partial second row of microtrichia that extend basally to level of submarginal vein; mandible with 3 teeth [Western North America] .... *E. yoshimotoi* sp. n.

– Forewing (Fig. 30) with narrow, linear asetose area behind venation (between level of hypochaeta and first distal macrochaeta) and in front of two rows of microtrichia that extend basally to level of submarginal vein; mandible with 2 teeth [Eastern North America] .... *E. pengellyi* sp. n.

6(1) FWL/FWW less than 4.0; Nearctic .... *E. nearcticus* Yoshimoto

– FWL/FWW greater than 4.0; Palaearctic 7

7(6) Mesosoma deep, about 1.5 times as long as high and dorsum distinctly curved in lateral view (Fig. 43); forewing (Fig. 33) with about 8 microtrichia on blade behind apex of submarginal vein + base of marginal vein, arranged in 1-2 indistinct

rows; asetose area behind these (and in front of retinaculum) relatively wide [area concealed behind wings in Fig. 33] ....*E. confusus* sp. n.

– Mesosoma shallow (Fig. 44), about 1.8 times as long as high and dorsum much flatter in lateral view; forewing (Fig. 34) with about 15 microtrichia on blade behind apex of submarginal vein + base of marginal vein, arranged in 2-3 indistinct rows; asetose area behind these (and in front of retinaculum) relatively narrow ....*E. nipponicus* sp. n.

Eustochus atripennis (Curtis)

(Figs. 1–15 [but see comments below], 16, 25, 26, 35, 45, 46)

Mymar atripennis Curtis, 1832: folio 411 (description in key); Haliday, 1833: 350 (list).

Eustochus atripennis Haliday, 1833: 349 (description, transfer to *Eustochus*); Walker, 1846: 54 (list); Foerster, 1847: 226 (description), 233 (German record from Aachen); Blanchard, 1840: 293 (diagnosis); Dalla Torre, 1898: 428 (list); Ashmead, 1904: 363 (mention in key); Schmiedeknecht, 1909: 495 (list); Kryger, 1950: 63 (description); Debauche, 1948: 201 (description); Bakkendorf, 1965: 122 (key); Viggiani, 1970: 135 (male description); Trjapitzin, 1978: 967 (duplicate of Bakkendorf key); Graham, 1982: 221 (type material); Schauff, 1984: 51 (type material lost); Viggiani, 1989: 146 (male genitalia); Ulrich, 1999: 388 (collection record).

Diagnosis. **Female.** Body length 978 (820-1330, air and critical point dried specimens). Head width 201-251 (n=6). Mandibles each with 3 teeth (2 teeth in specimens from Japan that may be *E. atripennis*, see additional material, below), the middle tooth slightly the largest, the dorsal tooth blunt. Mesosoma length/height 1.29-1.44 (n=2). Ovipositor length 746-1007 (n=9), 1.55-1.78 times length of hind tibia; distinctly exserted beyond apex of metasoma, the exserted part slightly less than hind tibial length.

Antenna (Fig.16). Segment L (W) (n=10): scape 136-169 (32-41), pedicel 66-81 (30-36), fl_1 65-95 (15-20), fl_2 64-83 (17-20), fl_3 56-77 (17-20), fl_4 49-60 (22-32), fl_5 42-51 (29-40), fl_6 38-45 (34-45), entire clava 130-157 (55-79). Ratios of L/W: scape 3.74-4.79, pedicel 1.84-2.48, fl_1 3.82-5.48, fl_2 3.53-4.45, fl_3 3.29-4.1, fl_4 1.69-2.26, fl_5 1.16-1.54, fl_6 0.86-1.04, entire clava 1.84-2.46.

Wings (n=10). FWL 948-1282, FWW 323-454, FWL/FWW ratio 2.88-3.06. Distance between first and second distal macrochaetae 1.85-2.15 (n=6) times distance between proximal and first distal macrochaeta. HWL 841-1044, HWW 33-43.

Male. Body length 1075 (critical point dried specimen). Head brown, distinctly darker than yellowish brown body. Head (Fig. 45) large, with height 208, length on midline 149, width 307, and 1.55 width of mesosoma. Face in lateral view forming a distinct rounded protrusion just below eye level, with toruli facing obliquely upward and lower face and mouthparts strongly sunken in, in lateral view not visible due to protruding gena; face in anterior view with a curved row of 6 setae above mouth margin. Vertex small, without ocelli (cf. Viggiani 1970), and widely separated from back of head by occiput. Eye small.

Malar space as long as eye and malar sulcus absent. Gena 3 times width of eye. Mouth about two-thirds width of head, with mandibles huge and capable of overlapping, each with three teeth, the dorsal one blunt and set back, not in line with the two ventral teeth. Labrum with one median seta. Mesosoma narrow and reduced. Pronotum visible in dorsal view, divided medially. Propleura visible in dorsal view as protruding 'shoulders' lateral to pronotum. Mesoscutum small, triangular, margined laterally by posterior of each pronotal lobe. Notauli absent. Scutellum apparently not divided into anterior and posterior portions and without placoid sensilla. Dorsellum narrow. Propodeum with small spiracle separated about 3 times its diameter from dorsellum; propodeal seta midway between anterior and posterior margins of propodeum, slightly more medial in position than spiracle. Pronotal lobe length (maximum) 46, mesoscutum length 45, scutellum length 47, dorsellum length 14, propodeum length 122. Metasoma with petiole length 122. Gastral tergum1 overhanging entire petiole, approximate relative lengths of gt_1-gt_7 (along dorsal margin, critical point dried specimens) 11, 15, 12, 9, 9, 9, 4. Spiracle apparently present. Cerci with two dorsal setae longer than ventral two and curved. Gaster length (critical point dried specimen) 614. Genitalia as in Fig. 46.

Forewing present (cf. Viggiani 1970) but minute and almost haltere-like. Hindwing absent.

Antenna (Fig. 25) with 9 flagellomeres, the apical two widely joined, clava-like. Relative proportions of segments L (W) [number of longitudinal sensilla, when present; if different between left and right antenna, both numbers are given]: scape 130 (35), pedicel 72 (38), fl_1 42 (22), fl_2 41 (22), fl_3 39 (27/24) [1/0], fl_4 41 (26/34) [1/2], fl_5 36 (36) [2], fl_6 36 (37) [2/3], fl_7 43 (38) [2], fl_8 42 (39) [3], fl_9 44 (35) [3]. The widths of fl_3 and fl_4 differ between the left and right antennae due to the different numbers of longitudinal sensilla.

Discussion. This species is distinguished from the other species with long ovipositors by proportions of the funicle segments, microtrichial pattern behind the forewing venation, and relatively longer marginal vein. No other described species has such a long venation (distance between first and second distal macrochaeta at least 1.8 times distance between proximal and first distal macrochaeta).

The type material of *E. atripennis* is lost (Graham 1982). Haliday sent specimens to Spinola in Turin (MRSN) and Graham examined the one specimen of *E. atripennis* there. He suggested that it could be designated as neotype, if no undoubted Walker specimen were found. This specimen was examined by JH. It is still in good condition, exactly as Graham (1982) described it (complete, except right pair of wings missing) but is not designated as a neotype here because *E. atripennis* is not a problematic taxon and an objective definition of it is not necessary (ICNZ, 1999, Article 75). The specimen (MRSN) is labelled: 1. "Museo Zoologia/Torino - Italia". 2. "Eustochus/ atripennis Haliday/ Lectotype ♀/ M de V. Graham, 1972". This lectotype designation is incorrect, because the specimen was not from the original material seen by Curtis. If desired, the specimen certainly serves as an example of what Haliday meant when redescribing the species but there are many, more recently collected, specimens in several museums that can serve as well.

Material examined. Forty-seven females and 1 male on cards or points, 10 female and one male on slides (58 additional Swiss and one French specimen were examined many years

prior to the present study; they are listed here). **CZECH REPUBLIC, Bohemia:** Praha-Stomovka, 18-19August 1999, L. Masner, riparian, yellow pan trap (♀, CNC); Revnice environs, 20-21 August 1999, L. Masner, creek (♀, CNC). **ENGLAND, Avon:** Bristol, Hallen Wood, 22 July 1925 (♀, USNM); **Berkeshire,** Wytham, em., 8 September 1949, from soil under oak, G. C. Varley (2♀, BMNH); **Cornwall,** Scilly Is., Tresco, 21 September 1975, J. S. Noyes (♀, BMNH); **Devon,** Birchette Wood, 13-21 August 1980 (♀, BMNH); **Dorset,** Bournemouth, 13 July, 17 August, and September 1981, 28 June 1983, S. C. S. Brown (4♀, BMNH); **Greater London,** Richmond, 25 September 1907, C. Waterhouse (♀, BMNH); **Hampshire,** New Forest, 24 June 1954, J. Murgetroyd (♀, BMNH); Romsey, Awbridge, August, September 1981, June 1982. C. Vardy (9♀, BMNH). **FRANCE, Haute-Savoie:** Vongy, 11 June 1964, C. Besuchet, dead leaves (♀, MHNG). **GERMANY, North Rhine-Westphalia:** Bornheim-Brenig, no date, M. Boness, on red currant (♀, CNC). **HUNGARY, Somogy:** Mernye, 17 August–4 September 1985, N. D. Springate (3♀, CNC). **SPAIN, Navarra:** Artikutza, 29 May 1995, 600 m, 18 May 1997, 25 August–22 September, 6–20 October, and 20 October–17 November 1996, 590-610 m, L. Martinez de Murguia, Malaise trap (6♀, CNC, MZNA); Iratibizkar, 26 July 2000, E. Baquero, pitfall trap (2♀, CNC, MZNA). **SLOVENIA:** Bled, 5-12 August 1978, L. Huggert, luxuriant spruce forest, pan trap (♀, CNC); Rateče, 31 July–7 August 1978, L. Huggert, edge of marshy area, pan trap, (♀, CNC). **SWITZERLAND, Geneva:** Chancy, 8 May 1964, C. Besuchet, dead leaves (5♂, 23♀, CNC, MHNG); L`Allondon, 2 and 7 May 1959, C. Besuchet, sifting mosses (15♀, MHNG); **Ticino:** Rancate, 8 August 1963, C. Besuchet, dead leaves (28♀, CNC, MHNG); **Valais,** Euseigne, 1000 m, 10 July 1970, C. Besuchet, det. Viggiani, 1976 (5♀, MHNG); Vouvry, 27 March 1967, at base of old stump, det Viggiani, 1970 (♂, 2♀, MHNG); **Vaud,** Cossonay, 4 August 1953, C. Besuchet, in old stump (♀, MHNG).

Additional material (possibly *E. atripennis*). **JAPAN, Honshu:** Ibaraki, Mt. Tsukuba, 800 m, 18 September–2 October, 2-20 October 1989, M. J. Sharkey, pan trap (7♀, CNC). **SOUTH KOREA, Kangwon-Chucheon:** Nam-myeon, Hudong-li, 31 July–16 August 2003, Malaise trap in semi-shade, forest edge (♀, CNC). The South Korean specimen is as large as the European (especially British) specimens, but fl_4 is longer so it is only tentatively identified as *E. atripennis*. The Japanese specimens are smaller than *E. atripennis* from Europe and because we are not sure if they are conspecific with it, we list them separately here. The scanning electron micrographs were taken from the Mt. Tsukuba specimens and may be *E. atripennis*. They have a long marginal vein but bidentate, instead of tridentate, mandibles.

Eustochus besucheti Bakkendorf (Figs. 17, 27, 36, 37)

Eustochus besucheti Bakkendorf, 1965: 117 (description); Xu and Lin, 2003: 65 (list).

Diagnosis. **Female.** Body length 712-772 (n=3, critical point dried specimens). Head width 192 (n=1). Mandibles each with 3 teeth. Mesosoma length/height about 1.35. Ovipositor length 585, distinctly exserted beyond apex of metasoma and 1.85 times length of hind tibia.

Antenna (Fig. 17). Segment L (W) (n=1): scape 135 (32), pedicel 64 (31), fl_1 45 (18), fl_2 45 (18), fl_3 53 (20), fl_4 33 (30), fl_5 33 (36), fl_6 33 (39), entire clava 123 (58). Ratios of L/W: scape 4.21, pedicel 2.05, fl_1 2.48, fl_2 2.56, fl_3 2.68, fl_4 1.1, fl_5 0.92, fl_6 0.84, entire clava 2.15.

Wings (Fig. 27). FWL 810, FWW 229, FWL/FWW ratio 3.54. Distance between first and second distal macrochaetae 1.33 times distance between proximal and first distal macrochaeta. HWL 689, HWW 34.

Male. *Eustochus besucheti* is the only other species besides *E. atripennis* whose male is known, based on a single specimen from Laquintal, the type locality. Apart from apparently narrower fl_5 and fl_6 in *E. besucheti*, the males of the two species appear to be identical.

Discussion. This species is distinguished from *E. atripennis*, the only other European species with a long ovipositor, by its smaller size, shorter funicle segments, especially fl_4 (Fig. 17), shorter forewing venation, and less sclerotized posterior margin of the forewing just beyond the retinaculum.

Material examined. Three females on cards or point, one on slide. The holotype ♀ and allotype ♂ (MHNG) were not examined. **CZECH REPUBLIC, Bohemia:** Studnice near Jablonec nad Nison, 860 m, 14 July 1964, V. Martinek (♀, CNC). **SWITZERLAND, Turgau:** Unterwasser, 1440 m, 4 August 1984, L. Masner, screen sweeping (♀, CNC); **Valais,** Laquintal, 1400-1500 m, 1 July 1962, C. Besuchet, mosses (2♀, CNC). The Laquintal specimens examined were preserved in alcohol from the type locality, but not designated as paratypes by Bakkendorf (1965). They were critical point dried and point mounted by the senior author and distributed between MHNG and CNC, by permission of C. Besuchet.

Eustochus confusus Huber and Baquero, sp. nov. (Figs. 23, 33, 43, 47–50)

Diagnosis. Female. Body length 1100 (n=1, paratype on slide). Head width 230 (n=1). Mandibles tridentate, each with a small dorsal tooth and 2 larger teeth, the middle one thicker and longer than the ventral one. Mesosoma length/height about 1.5 (Fig. 43). Ovipositor length 338-356 (n=2), not exserted beyond apex of metasoma and less than (0.80-0.82 times) length of hind tibia.

Antenna (Figs. 23, 47, 48). Segment L (W) (n=2): scape 161-174 (38-40), pedicel 76-78 (32-33), fl_1 64-66 (20), fl_2 58-66 (21-24), fl_3 51-52 (20-21), fl_4 40-44 (28-31), fl_5 38-41 (29-35), fl_6 37-39 (29-41), entire clava 125-132 (46-48). Ratios of L/W: scape 4.21-4.39, pedicel 2.35-2.36, fl_1 3.24-3.29, fl_2 2.38-3.10, fl_3 2.54-2.60, fl_4 1.29-1.57, fl_5 1.08-1.38, fl_6 0.94-1.33, entire clava 2.58-2.87.

Wings (Figs. 33, 49). FWL 1083-1151, FWW 262, FWL/FWW ratio (n=1) 4.39. Distance between first and second distal macrochaetae 1.03-1.04 times distance between proximal and first distal macrochaeta (Fig. 50). HWL 857-916, HWW 33-41.

Discussion. This species is distinguished from the only other species with a non-exserted ovipositor in the Palaearctic region, *E. nipponicus*, by the deeper mesosoma that is dorsally more rounded in lateral view (Fig. 43) compared to a shallower mesosoma that is dorsally flatter in lateral view (Fig. 44) and the wider asetose area between the retinaculum and rows of microtrichia behind the venation (Fig. 33). In Europe, E. *confusus* is the only species with an ovipositor shorter than the hind tibial length. The other two, *E. atripennis* and *E. besucheti* have long, exserted ovipositors that are longer than the hind tibia. It differs from *E. nearcticus* by its narrower forewing (length/width ratio about 4.4).

Material examined. Two females on slides. **HOLOTYPE** ♀ (MZNA) on slide labelled: 1. "MZNAXA098a /Irati (Navarra, Spain), /18.IX.1982/ UTM:30TXN5460,/390 m, UNZYEC leg./ MUSEO DE ZOOLOGÍA/UNIV. DE NAVARRA". 2. "Eustochus confusus Huber and Baquero. Holotype ♀". The holotype is complete and was originally uncleared and mounted laterally in Hoyer`s medium under a single cover slip (Fig. 23, 33, 43). After being photographed it was cleared and remounted in Canada balsam. **PARATYPE.** Same data as holotype (♀, MZNA).

Species name. The species name, *confusus*, is Latin for confusing. It refers to the initial confusion we had as to whether *E. confusus* was the same as *E. nearcticus* or not. If it had been, it would be the first *Eutochus* species occurring in both Europe and North America. While this is possible, because soil brought to North America as ballast in ships may have contained parasitized hosts, it is unlikely, given the occurrence of both species in localities that are not particularly near ports and that consist of native vegetation rather than human altered habitats.

***Eustochus nearcticus* Yoshimoto** (Figs. 18, 28, 38, possibly also 22, 32, 42)

Eustochus nearcticus Yoshimoto, 1990: 96 (description).

Diagnosis. **Female.** Body length 690-717 (n=2, critical point dried specimens). Head width 194 (n=1). Mandibles each with 3 teeth, the dorsal one smaller than the ventral two. Mesosoma length/height 1.55 (n=1) (Fig. 38). Ovipositor length 256-268 (n=2), 0.69-0.76 times length of hind tibia; not exserted beyond apex of metasoma.

Antenna (Fig. 18). Segment L (W) (n=2): scape 125-141 (30-32), pedicel 66-69 (29-30), fl_1 55-66 (15), fl_2 52 (19-20), fl_3 44-46(17-18), fl_4 41-47 (22-24), fl_5 38-40 (29), fl_6 36-37 (32-35), entire clava 124-129 (39-50). Ratios of L/W: scape 4.17-4.44, pedicel 2.30-2.33, fl_1 3.66-4.42, fl_2 2.62-2.76, fl_3 2.47-2.68, fl_4 1.73-2.09, fl_5 1.32-1.41, fl_6 1.05-1.12, entire clava 2.48-3.32.

Wings (Fig. 28). FWL 978-1048, FWW 278-283, FWL/FWW ratio 3.46-3.85. Distance between first and second distal macrochaetae 1.03-1.09 times distance between proximal and first distal macrochaeta. HWL 778-863, HWW 30-31.

Discussion. *Eustochus nearcticus* is the only described species with a short ovipositor (Fig. 38) in the Nearctic region. It is distinguished from the two Palaearctic species with short

ovipositors by proportions of the forewing and mesosoma. *Eustochus nearcticus* differs from *E. nipponicus* by its deeper mesosoma (length/height ratio about 1.5 compared to about 1.8), with a more rounded dorsum in lateral view. It differs from *E. confusus* by its wider forewing (length/width ratio at most 4.08).

Several specimens from western North America (AB, BC, MT) and southeastern USA (NC) may belong to *E. nearcticus*. We exclude them because we are not sure that they really are conspecific. They are listed separately below. Minor differences in their antennal proportions (funicle segments relatively short, somewhat as in *E. confusus*, in those specimens slide mounted and measured) size of bare area in front of fore-wing retinaculum, and height of mesosoma (e.g., Figs. 22, 32, and 42, all from a specimen from NC), may reflect intraspecific variation within *E. nearcticus* but may also indicate that they are a separate species. A conservative approach is taken here and they are excluded from *E. nearcticus* until more material, especially from intervening areas, becomes available for detailed study. The antenna (Fig. 22) of the NC specimen resembles that figured by Yoshimoto (1990, fig 36) in that fl_1 is relatively short, compared to Fig. 18. Both of the latter figures are specimens from the type localities.

The specimens from British Columbia appear to have a flatter mesosoma, more resembling *E. nipponicus*, than the point-mounted paratypes of *E. nearcticus*. It is difficult to be sure how these specimens are distinguished from *E. nipponicus*. However, the western Nearctic specimens all appear to have fl_1 slightly longer than fl_2, whereas *E. nipponicus* has fl_1 shorter than fl_2. If they are indeed the same species as *E. nipponicus* then wider species limits would then have to be accepted. Similarly, *E. nearcticus* specimens from eastern Canada may be the same as *E. confusus*, but, if so, wider species limits would again have to be accepted. Finally, the western specimens may represent a different species from either *E. nipponicus*, *E. confusus*, or *E. nearcticus*, and possibly could be defined geographically as well as morphologically. But since several specimens, possibly of *E. nearcticus*, are from Ontario it is difficult to define the two populations geographically. It is also possible that *E. nipponicus* and *E. confusus* are the extremes of only one species occurring across the Palaerctic region, but so far no *Eustochus* resembling these two species has been collected between Spain and Japan.

We prefer to treat the specimens with short-ovipositors as three species, with *E. nearcticus* occurring in northeastern North America but not in the Palaearctic region, and *E. nipponicus* distinct from *E. confusus* in the Palaeactic region. Much more material of these species is required, especially from intervening areas, to verify their status relative to one another and determine how many species really are involved.

The craterlike pits on the propodeum, visible on the scanning electron micrograph in figure 148 of Yoshimoto (1990), are an artifact, presumably due to remnants of a liquid deposit on the specimen. Cleared, slide mounts prepared of two specimens from the type locality do not show these pits; the sculpture is uniformly reticulate.

Material examined. Three females on points, two on slides. The holotype (CNC) is complete and in good condition on a point. Three paratypes from Nova Scotia, as listed in the original description, were also seen. The fourth paratype, from British Columbia, is a different species, assigned here to *E. yoshimotoi*, sp. n. (see below). The paratype from MacKenzies Mt. was slide mounted for detailed study. An additional specimen from

MacKenzies Mt., listed below, was also slide mounted; it was not included in the type series by Yoshimoto (1990), for unknown reasons.

CANADA, Nova Scotia: Cape Breton Highlands Nat. Park, MacKenzies Mt., 9 August 1983, J. E. H. & R. J. Martin (♀, CNC).

Additional material. Thirteen other specimens that may be *E. nearcticus* were examined, 3 of them (MT and NC) are on slides. **CANADA, Alberta:** Waterton Lakes National Park, 2 August 1985, Cameron Creek on Akamina Parkway near mouth of Rowe Creek, gravel in riffle, I. M. Smith (♀, CNC). **British Columbia:** Kootenay National Park, Daer Pitts, 16-30 July 2000, G. Gareau, MT, aspen (2♀, CNC). **Ontario:** Brucedale Conservation Area near Port Elgin, 19 April–16 June 1988, C. Dondale and J. Redner, pit fall trap at edge of swamp (♀, CNC). **UNITED STATES: Montana, Flathead Co.**, Glacier National Park, N. Fork Flathead area, S. Big Prairie, 3560', T35N R21W, sect. 16, 10-17 August 1993, M. A. Ivie, old growth light burn (2♀, CNC). **North Carolina: Jackson Co.**, Whiteside Mt., near Highlands, 1600 m, April–20 July 1987, CNC Hym. Team, oak forest (2♀, CNC); **Swain Co.**, Andrews Bald, pitfall 51, N 35° 20"32' W 83° 39"29', 10-24 May, 6-22 June, and 10-25 September 2001, Parker, Stocks, Petersen (5♀, CNC).

Eustochus nipponicus Huber and Baquero, sp. nov. (Figs. 24, 34, 44)

Diagnosis. Female. Body length 947-1100 (n=3, critical point dried specimens). Head width 188-198. Mandibles each apparently tridentate, with 2 large ventral teeth and a small, dorsal tooth. Mesosoma length/height 1.82 (Fig. 44). Ovipositor length 281 (holotype), not exserted beyond apex of metasoma and less than (0.91 times) length of hind tibia.

Antenna (Fig. 24). Segment L (W) (holotype): scape 138 (35), pedicel 69 (32), fl_1 51 (19), fl_2 51 (20), fl_3 41 (20) fl_4 44 (24), fl_5 39 (29), fl_6 37 (32), entire clava 110 (54). Ratios of L/W: scape 3.89, pedicel 2.19, fl_1 2.71, fl_2 2.62, fl_3 2.01, fl_4 1.40, fl_5 1.36, fl_6 1.15, entire clava 2.03.

Wings (Fig. 34). FWL 974, FWW 232, FWL/FWW ratio 4.09. Distance between first and second distal macrochaetae 1.04 times distance between proximal and first distal macrochaeta. HWL 823, HWW 34.

Discussion. This species is distinguished from *E. confusus*, the only other Palaearcic species with a short ovipositor, by the shallower mesosoma with a flatter dorsum in lateral view, and the narrower asetose area between the retinaculum and rows of microtrichia behind the venation (Fig. 34).

Material examined. Four females, one on a slide. **HOLOTYPE** ♀ (CNC) on slide labelled: 1. "Japan: Honshu/, Iwate, Iwaizumi/ Hitsutori, 770m/11-17.viii.1991/ A. Smetana [J47]". 2. "Eustochus/ nipponicus/ Huber &/ Baquero/ Holotype ♀". The holotype is cleared and mounted laterally (Fig. 44) under a 6 mm cover slip, with the wings and one antenna under two additional cover slips. **PARATYPES.** Same locality data as holotype (2♀, CNC); Iwate, Kawai, Yoshibezawa, N 39° 37' E 141° 31', 500 m, 25 August 1996, L. Masner, screen sweeping (♀, CNC).

Species name. The species is named from the Japanese name for the country of origin, Nippon.

Eustochus pengellyi Huber and Baquero, sp. nov. (Figs. 20, 30, 40)

Diagnosis. **Female.** Body length 666-896 [up to 973 when gaster somewhat inflated] (n=8, critical point dried specimens). Head width 184 (holotype). Mandibles each with 2 teeth. Mesosoma length/height 1.33-1.44 (n=3, critical point dried specimens). Ovipositor length 439, 1.40 times length of hind tibia and distinctly exserted beyond apex of metasoma.

Antenna. Segment L (W) (holotype): scape 121 (30), pedicel 62 (27), fl_1 50 (14), fl_2 46 (17), fl_3 39 (20), fl_4 38 (23), fl_5 36 (27), fl_6 35 (29), entire clava 105 (54). Ratios of L/W: scape 4.08, pedicel 2.29, fl_1 3.63, fl_2 2.62, fl_3 1.97, fl_4 1.66, fl_5 1.33, fl_6 1.22, entire clava 1.93.

Wings. FWL 799, FWW 228, FWL/FWW ratio 3.51. Distance between first and second distal macrochaetae 1.15 (1.30 on other wing) times distance between proximal and first distal macrochaeta. HWL 668, HWW 26.

Discussion. This species is distinguished from *E. yoshimotoi*, the only other Nearctic species with a long, exserted ovipositor, by a narrower asetose area above the retinaculum that is separated from the venation by only one complete line of microtrichia (wider asetose area and at least a partial second line of microtrichia in *E. pengellyi*). It differs from *E. atripennis* by its shorter venation, from *E. besucheti* by antennal proportions, and from *E. triclavatus* by the number of claval segments. The specimens from Japan that we treat as possibly *E. atripennis* on the basis of a long venation, also have bidentate mandibles.

Material examined. Thirteen females, two on slides. **HOLOTYPE** ♀ (CNC) on slide labelled: 1. "CANADA: ON/, Flint Hill near/ Kemptville/, 19-20.vii.1983/, L. Dumouchel". 2. "Eustochus/ pengellyi/ Huber and Baquero ♀/ Holotype". The holotype is cleared and mounted dorsally in Canada balsam under one 6 mm cover slip and the wings, and head, antennae and prothorax are under two other coverslips. **PARATYPES. CANADA, Ontario: Frontenac Co.**, 5 km W. Chaffey's Locks, Skycroft Campground, 9-14 July 1987, B. Hubley, MT (2♀, CNC); Thetford, 10-13 October 1982, A. Tomlin, FIT (♀, CNC); Haliburton Forest and Wildlife Reserve, N 45° 15' W 78° 35', 12 July 2001, C. Vance, maple forest, MT (♀, CNC); 7 km SE Westport, 134 m, N 44° 37"727' W 76° 21"545', 1-31 August 2005, S. Peck, maple sugar bush, FIT (♀, CNC). **Quebéc,** Lac Jean-Venne, N 45° 41' W 76° 03', 15-20 June, *Osmunda* marsh, YPT and 14-21 August 1995, L. Masner & J. Denis, *Osmunda* marsh creek, YPT (2♀, CNC). **UNITED STATES, Indiana: Laporte Co.**, Indiana Dunes National Lakeshore, Heron Rookery, 29 July 1997, R. Grundel, MT (2♀, CNC, USNM). **Maryland: Prince George's Co.**, Beltsville-Agricultural Research Centre, 1-9 July1980, K. Thorpe, Malaise trap on corn field edge (♀, USNM). **Tennessee: Blount Co.**, Cades Cove, N 35° 25"35' W 83° 17"50', 29 July1997, R. Grundel, MT (2♀, CNC).

Species name. The species is named in honour of Dr. David Pengelly, whose enthusiasm for teaching entomology encouraged several students to pursue insect taxonomy as a career.

Eustochus triclavatus Xu and Lin (Figs. 19, 29, 39)

Eustochus triclavatus Xu and Lin, 2003: 66 (description).

Diagnosis. **Female.** Body length about 720 (n=1, ?paratype on slide). Head width 193. Mandibles each with 3? teeth (not clearly visible). Mesosoma length/height 1.35. Ovipositor length 415, distinctly exserted beyond apex of metasoma and 1.16 times length of hind tibia.

Antenna (Fig. 19). Segment L (W) (?paratype): scape–[not measurable] (ca. 23), pedicel 63 (24), fl_1 47 (15), fl_2 52 (15), fl_3 47 (14), fl_4 52 (20), fl_5 45 (23), fl_6 41 (23), entire clava 137 (40). Ratios of L/W: pedicel 2.58, fl_1 3.14, fl_2 3.46, fl_3 3.25, fl_4 2.57, fl_5 1.96, fl_6 1.77, entire clava ca. 3.42.

Wings (Fig. 29). FWL 857, FWW 264, FWL/FWW ratio 3.25. Distance between first and second distal macrochaetae 1.41 times distance between proximal and first distal macrochaeta. HWL 731, HWW 31.

Discussion. This species is distinguished from all others described so far by the three-segmented clava (two segmented in other species). It belongs to the group of species with distinctly exserted ovipositors.

Material examined. One female on slide. **CHINA, Shanxi:** Fengxian, ♀, 4 September 1999, N.Q. Lin, CNC. The locality (Baoji) given in the original description differs from the specimen label, quoted here; it is not certain whether this specimen is a paratype. The holotype ♀ (FAFU) was not examined.

The paratype is uncleared, poorly oriented, and the clava of each antenna is slightly collapsed. It appears to have the division between claval segments 2 and 3 less distinct and perhaps incomplete, at least on one antenna.

Eustochus yoshimotoi Huber and Baquero, sp. nov. (Figs. 21, 31, 41)

Diagnosis. *Eustochus yoshimotoi* is one of two Nearctic species with a distinctly exserted ovipositor. It is distinguished from the other, *E. pengellyi*, by the wider, more distinct asetose area behind the marginal vein (narrower in *pengellyi*) and the tridentate mandible (bidentate in *E. pengellyi*).

Description. Female. Body length 845 (n=3, critical point dried specimens). Head width 211 (n=2). Mandibles each with 3 teeth. Mesosoma length/height 1.29-1.48. Ovipositor (Fig. 41) distinctly exserted beyond apex of metasoma, 485-525 (n=3) long and 1.24-1.32 times length of hind tibia.

Antenna (Fig. 21). Segment L (W) (n=2): scape 135-144 (32-33), pedicel 66-71 (32-33), fl_1 55-60 (17), fl_2 48-56 (17), fl_3 44-54 (19-20), fl_4 39-44 (27-29), fl_5 39-41 (34),

fl_6 39-40 (38), entire clava 121-138 (57-59). Ratios of L/W: scape 4.06-4.28, pedicel 2.07-2.10, fl_1 3.27-3.51, fl_2 2.80-3.19, fl_3 2.25-2.87, fl_4 1.43-1.55, fl_5 1.14-1.20, fl_6 1.05-1.06, entire clava 2.03-2.59.

Wings (Fig. 31). FWL 950-994, FWW 281-298, FWL/FWW ratio 3.33-3.44. Distance between first and second distal macrochaetae 0.90-1.02 times distance between proximal and first distal macrochaeta. HWL 739-809, HWW 38-41.

Material examined. Seven females, four of them on slides. **HOLOTYPE** ♀ (CNC) on slide labelled: 1. "USA, WA,/ Pierce Co./ Ashford/ 1-14.viii.1985/ L. Masner, Malaise trap". 2."*Eustochus/ yoshimotoi* ♀/ Huber and/ Baquero/ Holotype". The holotype is cleared and mounted laterally under one 6 mm cover slip in Canada balsam and the wings are under another coverslip. **PARATYPES.** Same data as holotype (4♀, CNC, USNM); **CANADA, British Columbia,** Vancouver Is., Mesache Lake, July 1984, MT, Sharkey–Johnson (♀, CNC). **UNITED STATES, California, El Dorado Co.**, Blodgett Forest, 27 August 1975, F. Andrews, M. Wasbauer, *Pinus ponderosa* log (♀, UCRC). The paratype from British Columbia was designated originally as a paratype of *E. nearcticus* by Yoshimoto (1990) and bears the paratype label "*Eustochus nearcticus*", as well as ours "*Eustochus yoshimotoi*".

Species name. The species is named in honour of Carl Yoshimoto, the senior author's predecessor with the Canadian Forest Service, who was a taxonomist at the CNC and described the first North American species of *Eustochus*.

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A NEW GENUS AND SPECIES OF PERILAMPIDAE (HYMENOPTERA: CHALCIDOIDEA) WITH UNCERTAIN PLACEMENT IN THE FAMILY

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A new genus and species of perilampid wasp is described from Yemen and Israel. The features of the adult do not allow for accurate placement within any of the existing subfamilies of Perilampidae. The adults are similar to Chrysolampinae; however, the mandibles have a 3/2 formula and although the ventral surface of the male scape has distinct pores, these are not isolated within pits or depressions, which is characteristic of Chrysolampinae and Perilampinae. The labrum is similar to most Perilampinae, but the prepectus is associated with the mesepimeron and not the pronotum. The ovipositor is strongly expanded at the apex and scimitar-shaped, whereas the ovipositor in all other Perilampidae is needle-like. The morphological features that relate to the potential phylogenetic placement of this genus in the perilampid/eucharitid complex are discussed.

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Introduction

The composition and higher level relationships of Perilampidae are uncertain. There has been debate over the inclusion of Akapalinae, Chrysolampinae, Echthrodapinae, and Philomidinae together with the more easily characterized Perilampinae within a single family (Ferriére and Kerrich 1958; Riek 1966; Graham 1969; Bouček 1972, 1983, 1988; Burks 1979; Bouček and Rasplus 1991; Darling 1986, 1995; Noyes 1990; Gibson et al. 1999). Echthrodapinae are now placed in Torymidae (Grissell 1995). Together or in part, these problematic subfamilies have also been proposed as a sister group or paraphyletic grade to Eucharitidae (Darling 1988, 1992; Gibson et al. 1999). Support for a close relationship between these groups is based almost entirely on morphology and behavior of the first-instar larva or planidium (Heraty and Darling 1984; Darling 1988, 1992; Heraty et al. 2004). The planidia of the eucharitid subfamilies, Gollumiellinae, Oraseminae, and Eucharitinae, are all very similar and several features support the monophyly of the Eucharitidae (Heraty and

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Darling 1984; Heraty et al. 2004). The life history and immature stages of Akapalinae, which has been placed in either Perilampidae or Eucharitidae, are unknown. In an analysis of 20 morphological features of immature stages, Chrysolampinae were sister to Philomidinae + (Perilampinae + Eucharitidae), with the latter three groups united by features of the planidium that include presence of a straplike tergite, absence of larval antennae, and an eversible postlabium (Darling 1992). Similar results were obtained from a combined larval and adult morphology dataset (Gibson et al. 1999). Initial results from molecular analyses with 28S-D2 ribosomal transcript supported monophyly of Eucharitidae (two genera), but not Perilampidae + Chrysolampinae, although with only four taxa sampled, the results are not reliable (Campbell et al. 2000).

Adults of Chrysolampinae and Perilampinae share two apomorphic features: one or more pores concentrated within distinct pits or depressions on the ventroapical surface of the male scape, and the gaster high and triangular in profile with the 2nd and 3rd gastral tergites subequal in size and fused medially (Darling 1986, 1997; Gibson et al. 1999). Philomidinae have been tentatively placed within Perilampidae (Noyes 1990, 2002), but other than possessing a similar compressed antennal flagellum and a similar gaster shape, there are no compelling adult characters to support this grouping. Similarly, the only adult feature of consequence grouping Perilampidae and Eucharitidae is the flap-like labrum with marginal setae (Darling 1988a); the labrum of Philomidinae is very different and more similar to Chalcididae (Darling 1988a; Gibson et al. 1999).

Chrysolampinae are easily recognized but difficult to define with synapomorphies. Apart from what defines Perilampidae as a whole, Chrysolampinae have only a single prominent synapomorphy — the mandibles each with two sharp apically positioned teeth (Bouček 1972, 1988; Darling 1986). Darling (1986, 1988) proposed that the flap-like structure of the labrum with marginal setae (and no digits) could be another synapomorphy, although some species that are referable to *Chrysolampus* have since been discovered to have a digitate labral margin, as is typical of Eucharitidae and some Perilampinae (Darling, unpublished).

Perilampinae are easily recognized and have a number of diagnostic and apomorphic features (Bouček 1978, 1988). Synapomorphies of Perilampinae include fusion or at least a very close association between the prepectus and pronotum, and pronotum with a dorsal collar (Bouček 1978). The labrum of Perilampinae is flap-like, digitate, and medially incised (Darling 1988). Most species also have a pair of aboral digits or sessile setae, and a pair of translucent areas that are interpreted as vestigial sockets (Darling 1988). The groundplan structure in Perilampidae is considered to be a fan-like labrum with marginal digits as in Eucharitidae, although aboral digits are possibly a groundplan feature (Darling 1988). Perilampinae all have 3/2 dentate mandibles, but this is likely plesiomorphic for Chalcidoidea (Bouček 1978).

Philomidinae do not help to resolve the relationships of Chrysolampinae and Perilampinae. The subfamily is highly autapomorphic in morphology. Adults share with Perilampidae a compressed, densely setose antennal flagellum, and the basal tergite (Gt_1) with distinct dorsal and lateral panels, but the labrum is sclerotized, flap-like, and broadly attached ventrally to the epipharynx with scattered surface setae (as in Chalcididae), the prepectus is swollen and shoulder-like, and the pronotum is reduced and obscured in dorsal view (Darling 1988; Heraty and Darling, unpublished). Like Chrysolampinae, the mandibles

are bidentate with sharp apical teeth. If Philomidinae are part of this same lineage, as suggested by the morphology of the first-instar larva, then the bidentate mandibles are potentially plesiomorphic for Chrysolampinae.

Recently, a species representing a new genus of chalcidoid wasp was collected in Israel and Yemen. It has features shared with both Chrysolampinae and Perilampinae that suggests that it may be either a plesiomorphic perilampid or a potential sister group to one or both of these subfamilies. Our purpose here is not to provide a final and formal placement of this genus, but to establish its name and provide a detailed discussion of important features as a prologue to more in-depth morphological and molecular studies that are in progress on the higher relationships of the perilampid-eucharitid complex.

Methods and Materials

Terms follow Darling (1988; for mouthparts), Heraty (2002), Gibson (1997), and Heraty and Quicke (2003; for ovipositor). Our terms differ in one major aspect involving the apex of the antennal flagellum. In many Chalcidoidea with an apparent 13-segmented antenna, the apical segment of the clava often has a small button-like apical sensillar area beyond flagellomere 11 (fl_{11}; antennomere 13) that is differentiated to the same degree as between fl^{10} and fl^{11}, but with no multiporous plate sensilla (Fig. 2, fl_{12}). The archaic family Rotoitidae has a 14-segmented antenna (Bouček and Noyes 1988), and we consider this button-like structure in these and other Chalcidoidea as homologous to the 14th flagellomere of Rotoitidae. Therefore, a 14-segmented antenna is a more general condition across Chalcidoidea. Colour versions of the figure plates are accessible from JMH or http://hymenoptera.ucr.edu.

Jambiya vanharteni n. gen. and n. sp. (Figs. 1–23)

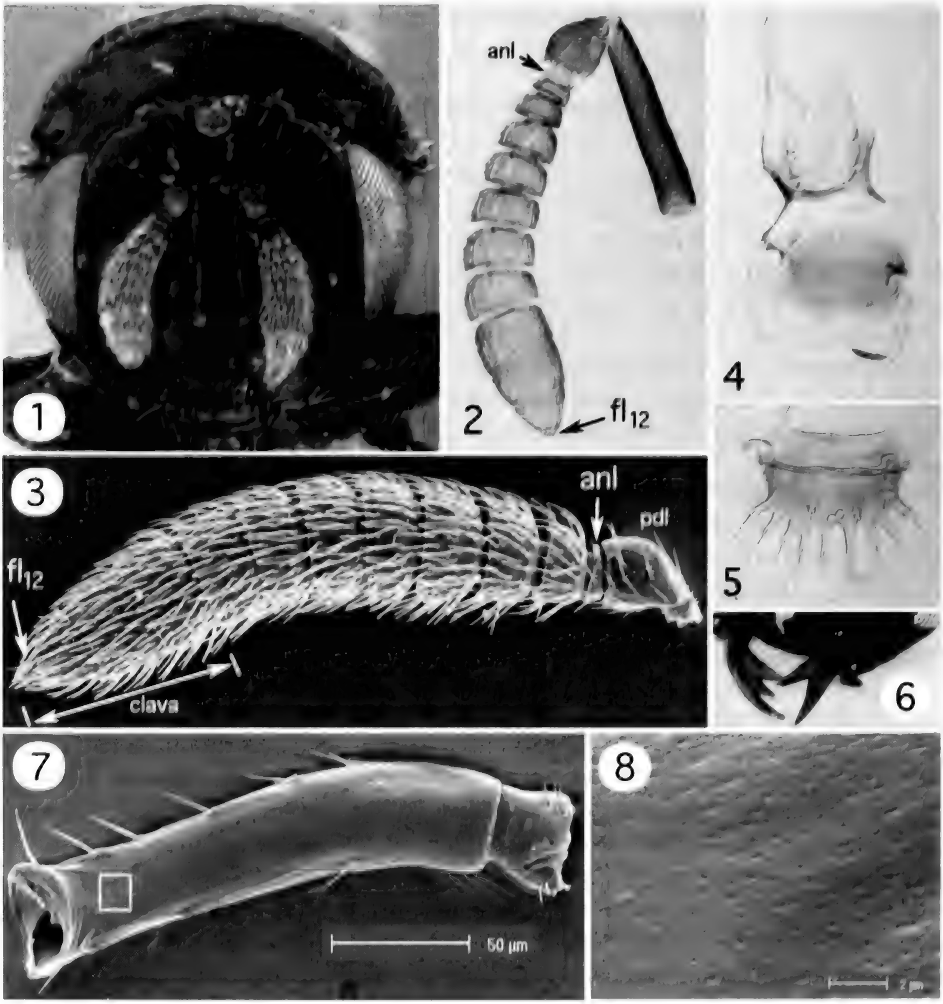
Etymology. *Jambiya* is treated as an arbitrary combination of letters; the gender is considered to be female. The name is based on the name of the small curved Yemeni dagger of the same name which is similar in form to the female ovipositor. The species is named after Tony van Harten, the collector of the specimens from Yemen.

Current placment. *Incertae sedis* within Perilampidae (see discussion below).

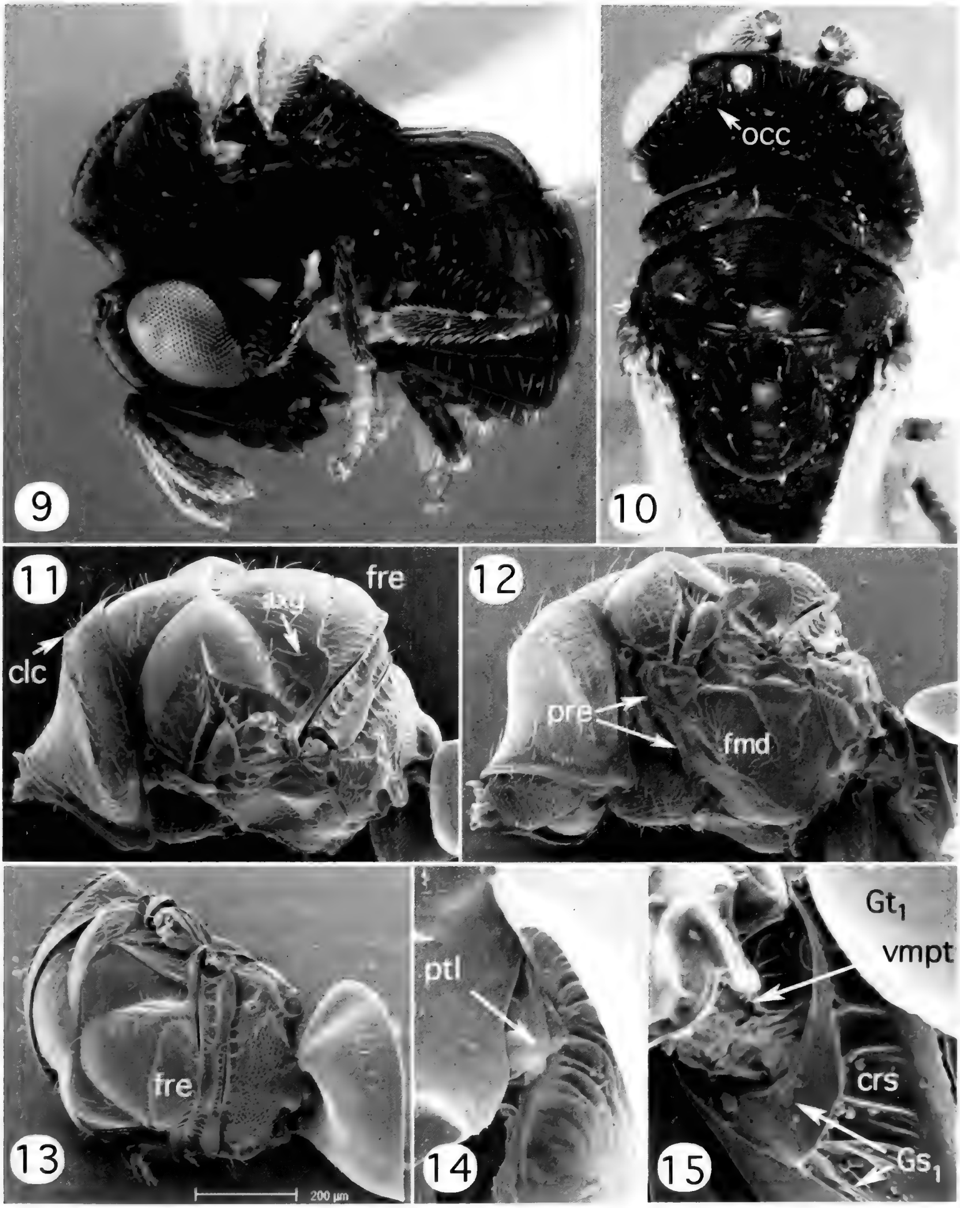
Diagnosis. In *Jambiya,* the mandibles are 3/2 toothed (Fig. 6), the epipharynx has a single pair of epipharyngeal setae (Fig. 4), the labrum is flap-like and digitate with paired aboral digits and translucent areas (Fig. 5), the petiole is membranous ventrally (Fig. 15), the ventral surface of the male scape has scattered minute pores without prominent pits or depressions (Figs. 7, 8), the mucro is long and acuminate (Fig. 20), and the ovipositor is apically expanded and dentate (Fig. 20). This genus is similar to *Chrysomalla* (Chrysolampinae), which also has the distinct carina demarking a pronotal collar and a ventrally membranous petiole, but differs in several key features considered as diagnostic of the subfamily. *Jambiya* differs from all known genera of Perilampinae by having the labrum not medially incised, ventral

surface of the male scape without any distinct pits (although minute pores are present), pronotum and prepectus + mesepisternum loosely articulated, ovipositor with the ventral valves expanded and flattened, and in several aspects of the forewing venation (parastigmal break, linear stigmal sensilla, short postmarginal vein). Without any congeneric species for comparison, all of the generic diagnostic features are also relevant for species recognition.

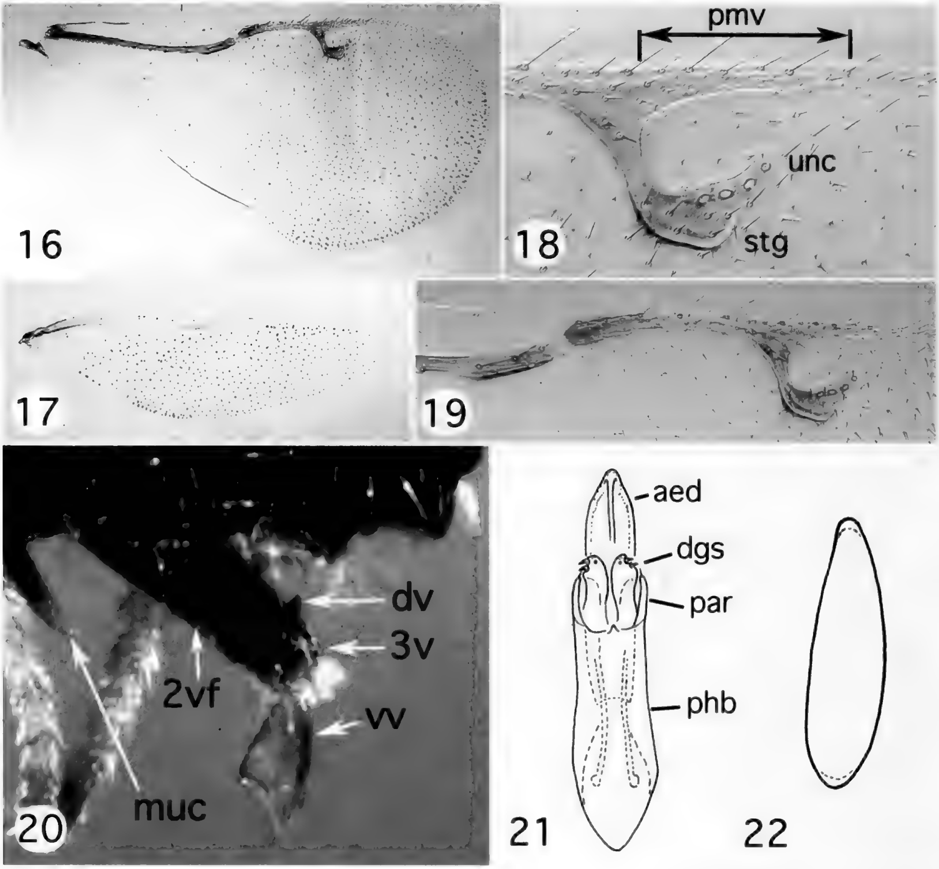
Female. Length 1.1-1.3 mm. Body color black with iridescent bluish reflections; tarsi pale brown; ovipositor valves light brown. Wings hyaline, forewing venation brown.



FIGURES 1–8. *Jambiya vanharteni.* 1–female head in frontal view; 2–female antenna; 3–male antenna, 4–epipharynx; 5–labrum; 6–mandibles; 7–male scape, ventral view; 8–closeup of inset box from Fig. 7. Abbreviations: anl–anellus; fl_{12}–flagellomere 12; pdl–pedicel.



FIGURES 9–15. *Jambiya vanharteni*. 9–female habitus; 10–female head and mesosoma, dorsal view; 11–13, male mesosoma: 11–subdorsal view, 12–sublateral view, 13–posterodorsal view; 14–petiole in dorsal view, closeup of Fig. 13; 15, petiole and first sternite in subventral view. Abbreviations: axg–axillular groove; clc–collar; crs–crenulate sulcus; fmd–femoral depression; fre–frenum; Gs_1–gastral sternite 1; Gt_1–gastral tergite 1; occ–occiput; pre–prepectus; vmpt–ventral margin of petiole.



FIGURES 16–22. *Jambiya vanharteni.* 16–forewing; 17–hind wing; 18–stigmal vein; 19–forewing vein; 20–apex of gaster, lateral view; 21–male genitalia, ventral view; 22–ovariole. Abbreviations: aed–aedeagus; dgs–digitus; dv–dorsal valve; muc–mucro; par–paramere; phb–phallobase; pmv–postmarginal vein; stg–stigmal vein; unc–uncus; vv–ventral valve; 2vf–second valvifer; 3v–third valvula.

Head. Rounded in frontal view (Fig. 1); eyes bare; median ocellus anterior to lateral ocelli. Frons and lower face smooth and shining with scattered semi-erect setae; ocellar-ocular depression absent; scrobal depression finely reticulate, shallow with rounded lateral margins, and extending 2/3 distance to median ocellus; vertex lateral to ocelli transversely strigate; occiput circularly colliculate (Fig. 6), dorsal occipital margin with a sharp carina (Fig. 10, occ), carina extending to oral fossa although partially obscured ventrally by fine postgenal striae. Clypeus smooth with few scattered short setae, margins demarked dorsally and laterally by weakly impressed smooth sulci that are rounded at dorsolateral margins of clypeus (clypeus nearly semicircular), clypeal margin slightly rounded with a transverse shelf (Fig. 1); supraclypeal area indistinct. Malar sulcus demarked by a weak carina (Fig.

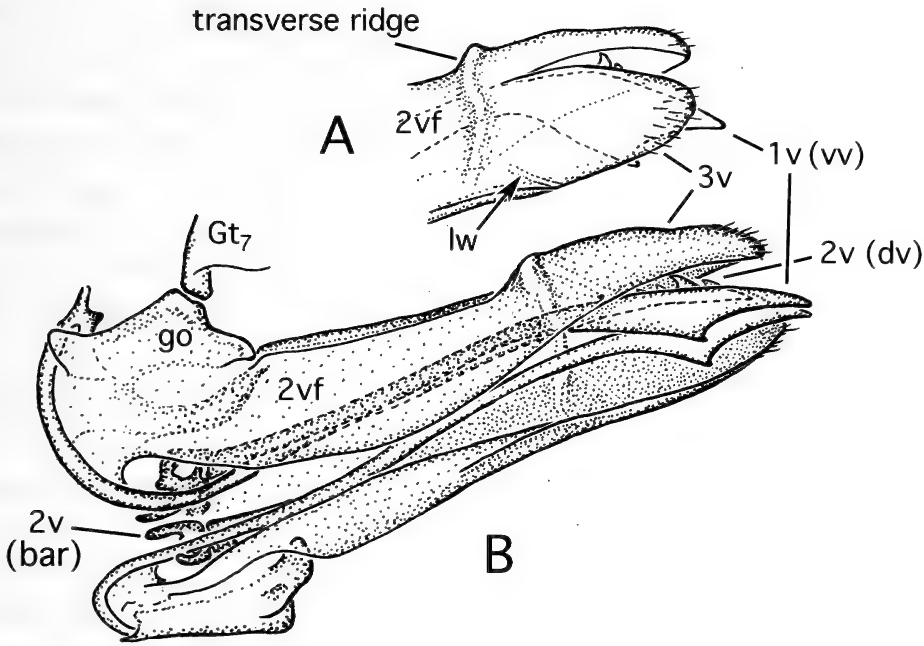


FIGURE 23. *Jambiya vanharteni*, ovipositor: A–dorsolateral view of apex; B–ventrolateral view. Abbreviations: dv–dorsal valve; go–gonangulum; Gt_7–gastral tergites 7; lw–line of weakness between third valvula and second valvifer; trs–triangular sclerite; v–valvula; vf–valvifer; vv–ventral valve.

6); hypostomal lobes broadly separated. Mandibles opposing, 3/2 dentate with teeth long and subequal (Fig. 6), basal articulation with gena membranous medially. Oral fossa broad. Epipharynx with single pair of stout epipharyngeal setae (Fig. 4). Labrum with 9 marginal acuminate digits, 2 aboral digits and 2 medial aboral translucent areas/vestigial sockets (Fig. 5); palpi 4/3 segmented. Antenna 14-segmented; scape narrow and elongate with no indication of ventral pits or pores in slide mounted antenna; anellus transverse (Fig. 2, anl); length of flagellum less than height of eye; funicle 7-segmented, all segments broader than long and slightly increasing in width apically; clava with four distinct, partially fused segments, apical segment (fl_{12}) small and button-like; multiporous plate sensilla large and numerous on all flagellomeres except flagellomeres 1–2 and flagellomere 12 (Figs. 2, 3); numerous socketed setae on pedicel and flagellum.

Mesosoma. Pronotum with distinct transverse collar demarked by a transverse carina (Figs. 9–12, clc); collar swollen and projecting laterally anterior to spiracle (Fig. 13), anterior face imbricate and mostly bare, mostly smooth posterior to carina and with scattered semi-erect setae; pronotum overlapping mesoscutum (Fig. 11). Mesoscutum mostly smooth with scattered setae; notauli deeply impressed and converging but not meeting at midline (Figs.

10, 11). Scutoscutellar sulci diagonal, meeting anteriorly at transscutal articulation; lateral axillar lobe rounded and smooth (Figs. 10, 11); scutellar disc smooth medially and weakly imbricate laterally, with scattered setae; axillular groove (axg) present but broad and only slightly raised above surface (Fig. 11). Frenal line present and complete dorsally; frenum (fre) broadly rounded, smooth medially and weakly striate laterally, extended only slightly over metanotum (Figs. 11–13). Metanotum with broad rounded flange laterally, overlapping propodeum but not overlapping propodeal spiracle (Fig. 13). Propodeum reticulate medially with a smooth nucha; spiracle separated from anterior margin by its diameter, margin of spiracle thick and raised (Figs. 11, 13); callus weakly sculptured with several long setae (Figs. 11, 12); metepimeral groove present and foveate. Femoral depression (fmd) broadly and shallowly impressed and weakly reticulate (Fig. 12); transepimeral sulcus present; transepisternal sulcus present and associated with a weak carina (Fig. 12); posterior margin of upper mesepimeron even and without any indication of the metathoracic spiracle. Prepectus (pre) associated with mesepimeron, not fused with pronotum, and in a different plane from pronotum (Fig. 12); dorsal half of prepectus ovoid with a broad foveate medial depression (Fig. 12), overlapping base of tegula (Fig. 12), ventral half strongly narrowed and associated with anterior inflected margin of mesepisternum; mesothoracic spiracle exposed and prominent (Fig. 12). Propleura broadly separated ventrally, meeting only near anterior margin (Fig. 12). Coxae smooth to weakly imbricate with scattered long setae; midcoxa less than half size of hind coxa, hind coax semiglobose and with several prominent long hairs dorsally; femora expanded medially; tibiae densely setose; fore tibia obliquely truncate apically and with one large, curved, and bifid spur; mid tibia with a single long spur almost as long as basitarsus; hind tibia with two spurs, longest half as long as basitarsus; all tarsi 5-segmented; claws simple. Forewing venation distinct (Figs. 16, 18, 19); submarginal vein with 7 long setae dorsally; parastigma with hyaline break and 2 campaniform sensilla along posterior margin (Fig. 19); stigmal vein broadened apically and with distinct uncus and 4 campaniform sensilla, stigmal vein roughly perpendicular to forewing margin; postmarginal vein extending beyond stigmal vein, but equal in length to vertical height of stigmal vein (Fig. 18); basal area bare except for track of setae along cubital vein, speculum irregular (mostly setose), costal cell with dense short setae; disc with dense fine setae and distinct marginal fringe, setal tracts on wing disc absent (Fig. 16). Hind wing venation complete, no trace of basal vein (submarginal vein parallel and continuous); 3 hamuli; fringe present.

Metasoma. Petiole short and transverse, visible only as narrow smooth band dorsally (Fig. 14), ventrolateral margins of petiolar tergite (vmpt) not fused and petiole membranous ventrally (Fig. 15); membrane attaching to anterior margin of gastral sternite; not overlapping. Gastral terga smooth to very lightly coriaceous; basal tergites ($Gt_{1\&2}$) tightly appressed, following tergites distinctly overlapping and articulating; Gt_1 depressed medially, anteriorly with medial crenulate depression, laterally with irregular patch of setae (Fig. 13); following tergites with single row of prominent setae (Fig. 9). Cerci circular with 5 setae. Sclerotized epiproct absent. Basal sternite (Gs_1) with transverse crenulate sulcus (crs) and raised flat anterior region (Fig. 15); hypopygium with long, bare mucro (Fig. 20, muc). Ovipositor sheaths long and parallel (Fig. 20, 2vf and 3v), second valvifer fused dorsally with a strong internal ridge across dorsal apical margin (Fig. 23), third valvula (3v) separated from

second valvifer by oblique suture (Fig. 23, posterior ventral margin of 2vf indicated by arrow), and apically with tuft of setae; ventral valve abruptly expanded apically, laterally flattened and scimitar shaped with 2 apical prongs (Fig. 20, vv); dorsal valve apically with 2 pronounced basally-directed, keel-like spines (Fig. 20, dv, one spine showing) and a minute spine subapical to these.

Male. Length, 1.02 mm. Dark brown to black. Antennal scape smooth ventrally (Fig. 7), minute pores present on ventral surface of scape, but visible only at high magnification, and scape lacking pits or depressions surrounding pores (Fig. 8). Gt_9 subtriangular and setose. Genitalia elongate (Fig. 21); aedeagus articulating and with prominent apodemes; parameres long and thin with a single apical seta; digitus broad, rounded, and with 2 marginal spines.

Ovarian egg. (Fig. 22). Length 0.15-0.16 mm. Cylindrical without apical stalk or surface sculpture.

Holotype. Female: **YEMEN**, 12 km NW Manakhah, 05 May–17 June 2002, A. van Harten; deposited in CNCI. **Paratypes. YEMEN**: same locality and collector data, but 3 July–21 August 2001 (♀), 6 July–21 August 2002 (♀, 2♂; ♀ with slide mount of antenna and one set of wings, base of metasoma on card, ovipositor in vial on pin; ♂ with head on card and slide mount of wings, antenna and genitalia; body used for SEM); **ISRAEL**: Arava Valley, 0.2 km N Hazeva Field, N 30°46'56" E 35°14'39", 26-27 April 1996, 450 ft, school in small wadi, M. E. Irwin (♂). All specimens deposited in CNCI.

Discussion

We are confident that *Jambiya* belongs to the family Perilampidae. The problem remains as to which subfamily it should be associated with, or if it deserves a new subfamily status. Several features are of interest in the placement of *Jambiya* and also affect our current treatment of the existing subfamilies of Perilampidae.

Male scape. In all Perilampinae and Chrysolampinae, the ventral subapical region of the male scape has distinct pits that are usually visible using simple light microscopy (Darling 1986, 1983, 1988b). Each of these pits is associated with 1 or more pores that are likely associated with pheromone glands (Darling 1986); pores do not appear in the surrounding interstices. The male scape of Philomidinae is reticulate without any visible pores, even in slide mounts (Heraty and Darling, unpublished). Males of some Eucharitidae (some *Gollumiella*, *Psilocharis*, and *Neolosbanus*) have scattered ventral pores visible only in slide preparations or under high magnification using SEM (Heraty 1994, 2004), however these are never associated with pits. Males of *Jambiya* have minute pores scattered over the ventroapical surface that are visible only with SEM, and no pits (Figs. 7, 8); pores are absent in the female scape. The presence of these scattered pores is likely a plesiomorphic condition among the pteromaloid Chalcidoidea, and possibly all Chalcidoidea (Heraty, unpublished). The association of pores with distinct pits is the derived feature of Chrysolampinae and Perilampinae which is not present in *Jambiya*.

Antennal flagellum. The antennal flagellum is similar in Chrysolampinae and Perilampinae (cf. Figs 2, 3). The groundplan segmentation of the flagellum includes a distinct transverse anellus (fl_1), followed by seven articulated funicular segments (fl_{2-8}) that are usually broader than long and slightly increasing in width apically, and finally a four segmented clava (fl_{9-12}) with the flagellomeres fused but clearly demarked. The apical flagellomere (fl_{12}) is small and button-like. Multiporous plate sensilla (MPS) and numerous stout socketed sensilla are present on at least flagellomeres 4-11 and the MPS are always absent on the anellus and flagellomere 12. Although there are exceptions within Chrysolampinae (*Brachyelatus*, *Austrotoxeuma*), the flagellum is compressed and much shorter than the head height, and often barely extending to the clypeal margin. Philomidinae differ only in that some males have ventrally ramose antennae, whereas they are always simple in other Perilampidae. In Eucharitidae, the antennal flagellum is much more elongate, and fl_{12} is never present in the same form (may be a complete additional segment in some more derived taxa, cf. Heraty 2002). Except for the absence of MPS on the second flagellomere, the antenna of *Jambiya* is similar to that of most Perilampidae; however many of these features are found in other Chalcidoidea and it is difficult to ascertain which attributes are synapomorphic for Perilampidae.

Epipharynx. Chrysolampinae and Philomidinae have two patches of epipharyngeal seta, whereas Perilampinae, all Eucharitidae, and *Jambiya* have a single pair of stout setae. The polarity of this character is uncertain (Darling 1988).

Labrum. The labrum of *Jambiya* is similar in some regards to both Chrysolampinae and Perilampinae, but not Philomidinae. A weakly sclerotized, flap-like labrum with evenly placed digits along the apical margin is known for only some *Chrysolampus* (Darling, unpublished). In most Chrysolampinae, digits are absent and the setae are arranged evenly along the apical margin (Darling 1988a). Within Perilampidae, aboral digits and paired transluscent areas are known only within Perilampinae (Darling 1988a). Furthermore, the labrum of Perilampinae is excised medially and arranged into two distinct lobes, with the translucent areas located along the inner margin of the lobes (Darling 1988a). Darling (1988a) proposed that aboral digits in Perilampinae were likely derived. Their presence in *Jambiya*, in combination with other characters, would suggest that aboral digits might be plesiomorphic for Perilampinae. The labral digits of *Jambiya* are finely tapered apically; they may be either tapered or spatulate in Chrysolampinae and Perilampidae; tapered digits are considered to be plesiomorphic (Darling 1988).

Pronotal-prepectal association. *Jambiya* and Chrysolampinae have the prepectus closely associated with the mesepimeron and broadly separated from the pronotum by a wedge-shaped gap along most of its anterior length (Fig. 12). The size of the gap is related to the orientation of the pronotum, and can be more correctly correlated with a close association of the prepectus with the mesepipleuron and not the pronotum. This form of the prepectus is typical for Pteromalinae, Torymidae, and other chalcidoids, and is presumed to be plesiomorphic. Philomidinae have a prepectus unique in Chalcidoidea. The articulation between the pronotum and prepectus is rigid and closely appressed, but the prepectus remains separate and uniquely overlaps the posteroventral margin of the pronotum. In

Perilampinae, Akapalinae, and Eucharitidae, the prepectus is more closely associated with the pronotum, and is fused to the pronotum in all Perilampinae (except *Steffanolampus*) and within Eucharitidae (Gollumiellinae and all Eucharitini) (Heraty 2002). Close association with eventual fusion of the pronotum and prepectus is considered the derived state (Heraty 2002).

Forewing venation. The wing venation of *Jambiya* is almost identical to that found in *Chrysolampus* or *Chrysomalla* (Chrysolampinae), including the presence of a hyaline break in the parastigma, shape of the stigmal vein and stigma, and length of the postmarginal vein (Figs. 16–19). The only difference is the linear arrangement of the campaniform sensilla along the uncus, which are clustered in Chrysolampinae (cf. Darling 1986). Perilampinae have no hyaline break, a distinctly different stigma, and a much longer postmarginal vein. The venation of Philomidinae is similar to Chrysolampinae, but without a hyaline break and they have numerous campaniform sensilla in the stigma that are arranged in a dense cluster (Heraty, unpublished).

Petiole. The petiole of *Jambiya* is short and smooth, with the ventral margins of the petiolar sclerite broadly separated by a membranous area, and the apex of the petiolar scperite abuts with the anterior margin of the first gastral sternite (neither overlapping or inserted). A ventrally membranous petiole is found in *Chrysomalla* (Chrysolampinae) and females of *Indosema* and *Timoderus* (Eucharitidae: Oraseminae). A ventrally membranous petiole is known in some Pteromalidae (cf. Heydon 1989) and whether it is a derived or plesiomorphic state is uncertain. In taxa with a fused petiole (i.e. *Orasema* in Oraseminae), the sternal antecostal muscles attach between the crenulate sulcus of the first gastral sternite and the ventral midline of the petiole (Heraty, unpublished). However, in *Jambiya*, these same antecostal muscles divide anteriorly and attach to the ventrolateral margins of the sclerotized portion of the petiole, suggesting that the remnant of the ventral (first) sternite of the petiole has been split. If so, this could be an apomorphic state within Chalcidoidea, although it is potentially plesiomorphic for Perilampidae or Perilampidae + Eucharitidae.

Gastral tergites. Perilampinae and Chrysolampinae have the gaster usually high and triangular in profile, with the first and second tergites usually similar in size, fused dorsally, and Gt_2 has a large lateral panel (Darling 1986, 1997). In these two subfamilies, the margins of the basal two terga are abutting and non-overlapping dorsally. Philomidinae have the basal tergite longer than the second and also overlapping the second tergite; the basal tergite (Gt_1) has a lateral panel, but this may be associated more with the odd shape of the gaster, which is strongly compressed dorsoventrally. The basal gastral tergites of *Jambiya* are subequal in length and with Gt_1 abutting Gt_2 (Fig. 9). These terga are not fused, and there is no distinct lateral panel on Gt_1. Although the basal tergite is broadly depressed medially, the gaster is rounded and not triangular (Fig. 9). Other than having closely associated and abutting basal tergites, the gaster of *Jambiya* is not similar to other Perilampidae.

Ovipositor. The ovipositor of *Jambiya* is unique within Chalcidoidea. The ovipositor valves in Chrysolampinae and Perilampinae are simple and needle-like. An expanded ovipositor with prominent ridges or spines is associated with oviposition into cavities formed in leaf

tissue occurs in the three subfamilies of Eucharitidae (Gollumiellinae, Oraseminae, and some Eucharitinae) and Akapalinae, although oviposition habits are unknown in this latter subfamily (Heraty 1994, 2002; Heraty et al. 2004). It is difficult to postulate a use for the peculiar ovipositor in *Jambiya*, however its form may suggest a habit of oviposition into leaf surfaces as is known for some Eucharitidae (Gollumiellinae, Oraseminae, and some Eucharitinae; Heraty 2002; Heraty and Quicke 1998). This raises the possibility that expanded ovipositor and leaf ovipositions are plesiomorphic for the perilampid/eucharitid complex.

Egg. *Jambiya* has a fusiform smooth egg (as inferred from ovarian eggs). Perilampinae have a fusiform egg with a sculptured surface (Heraty and Darling 1984; Darling and Roberts 1999) whereas Chrysolampinae have a fusiform, although slightly dumbbell-shaped egg, with a smooth surface (Darling and Miller 1991). The eggs of some Eucharitidae are fusiform and smooth, but most species have a stalked egg, both in the ovariole and after the egg is deposited (Heraty 1994, 2002). A fusiform egg is likely plesiomorphic.

None of the morphological features discussed above accurately places *Jambiya* within any of the perilampid subfamilies, and at best, the features of *Jambiya* confuse the putative synapomorphies of Chrysolampinae and Perilampinae. Although closest to Chrysolampinae, and especially the genus *Chrysomalla*, *Jambiya* lacks any of the defining characteristics of the subfamily. The antennae are similar in general form (antennal formula, compact flagellum, and dense setation) to all three subfamilies of Perilampidae, but the lack of pits on the male scape would seem to exclude this genus from either Chrysolampinae or Perilampinae. The single pair of epipharyngeal setae is shared with Perilampinae and Eucharitidae, but not Chrysolampinae or Philomidinae. The 3/2 mandibular formula excludes *Jambiya* from Chrysolampinae and Philomidinae. The labrum has a composite of features shared with Chrysolampinae and Perilampinae, but not Philomidinae. The pronotal-prepectal complex is likely plesiomorphic and uninformative. The wing venation is almost identical with some Chrysolampinae, but with a different arrangement of campaniform sensilla. Polarity is difficult to assess for the forewing vein features, but *Jambiya* is very different from either Philomidinae or Perilampinae. The petiole is membranous ventrally and similar to some Chrysolampinae and Eucharitidae, but the polarity of this feature is uncertain. The gastral tergites are closely associated and abutting, but otherwise it is not similar to other Perilampidae. The ovipositor is unique within Chalcidoidea, but has some similarities with Eucharitidae and Akapalinae that may be suggestive of oviposition into leaf tissue. Lastly, the egg is fusiform which is characteristic of Perilampinae and some Eucharitidae, but this is likely a plesiomorphic feature. In summary, *Jambiya* might well deserve subfamily status within Perilampidae. A combined morphological and molecular analysis is currently in progress which should resolve not only the placement of this enigmatic wasp, but also the phylogeny of the perilampid/eucharitid complex.

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PRELIMINARY EXAMINATION OF GUT BACTERIA FROM *NEODIPRION ABIETIS* (HYMENOPTERA: DIPRIONIDAE) LARVAE

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Abstract

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The gut microbiotas of insects are important for many processes, including digestion, nitrogen fixation, and nutrient recycling. Bacterial 16S ribosomal DNA (rDNA) extracted from excised *Neodiprion abietis* larval guts was amplified using PCR. Two combinations of primers produced six fragments that were separated using Denaturing Gradient Gel Electrophoresis (DGGE). The DNA fragments were sequenced directly. BLAST-n analysis and comparison-rank searches, using the Ribosomal Database Project II, revealed four predicted bacterial species, one that had similarity to Alphaproteobacteria and three that aligned with Gammaproteobacteria. Phylogenetic analysis by maximum parsimony and neighbour joining confirmed these findings and suggest that *Rahnella, Yersinia*, *Enterobacter*, and a *Caulobacter*-like species inhabit the *N. abietis* larval gut.

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Introduction

The balsam fir sawfly, *Neodiprion abietis* (Hymenoptera: Symphyta: Diprionidae), is an indigenous phytophagous insect in North America. The larvae feed predominantly on balsam fir (*Abies balsamea* Mill), but will also consume white spruce (*Picea glauca* Moench) and black spruce (*Picea mariana* Mill.) (Wallace and Cunningham 1995). Outbreak populations typically occur every 5-15 years, lasting 4-5 years in duration (Piene et al. 2001; Moreau et al. 2005). Larvae emerge in early summer after overwintering as eggs sheltered in the needles of the host plant. Male larvae pupate after their fifth instar, whereas female larvae may go through an additional instar before pupation. Adults emerge in late summer and, after mating, females lay eggs in current year foliage, using a saw-

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like ovipositor. The majority of current knowledge regarding diprionid sawflies is based on ecological (Wallace and Cunningham 1995; Li et al. 2005; Moreau et al. 2005) and anatomical studies (Bordas 1895; Maxwell 1955). Current knowledge of the structure and organization of the sawfly digestive tract is limited, and almost nothing is known about the microbiota of sawfly guts.

The insect gut is a complex and highly structured organ. Gut morphology and function are dependent on several factors: the insect taxon, its stage of development, feeding behaviour of each developmental stage, food source, environment that the insect inhabits, and the inhabiting microorganisms (Wigglesworth 1972; Chapman 1985; Nation 2002; Dillon and Dillon 2003). The first comparative review of hymenopteran guts was made, by Bordas (1895), describing the macro-morphology of guts from selected insects of every family in the order Hymenoptera. Sixty years later, Maxwell (1955) compared the internal anatomy of larvae from 132 species, in eleven families of North American and European sawflies, within the suborder Symphyta. Neither of these reviews on sawfly gut morphology mentioned gut microbes.

The natural microbiota of the gut represent microbial-host interactions that range from pathogenic to obligate mutualism. Studies that define the composition of microbial communities in the digestive system have primarily been performed using termites, tsetse flies, aphids, and cockroaches (Dillon and Dillon 2003). Recent interest in insect endosymbionts, such as bacteria in the genera *Wolbachia*, *Buchnera*, or *Wigglesworthia* bacteria, has increased our knowledge about relationships of microbes with their insect hosts. Termite microbiota are best characterized, primarily because the functional roles of gut microbes in other insects have not been investigated (Brune 1998; Bignell 2000; Breznak 2000). In termites, microbes are mainly located within specialized regions and structures of the gut. The majority of the termite microbiota are found in pouches of the hindgut, where bacterial densities can reach 10^{11} cells per ml of gastric fluid (Breznak and Pankratz 1977). In the midgut, microbial communities are typically sparse and tend to localize between the microvilli of the epithelial cells (Breznak and Pankratz 1977). Microorganisms may colonize the gut wall, attach to surfaces such as spines, or course freely in the lumen (Bignell 2000). Depending on the termite species and its food source, the functional role of the microbes may range from fermentation and hydrogen production to nitrogen recycling and carbon elimination (Breznak and Pankratz 1977; Brune 1998; Bauer et al. 2000; Bignell 2000; Brauman et al. 2001).

Recent studies of gut microbiota in the ant genera *Camponotus, Solenopsis*, and *Tetraponera* (Hymenoptera: Formicidae), have shown that bacteria localize to bacteriocytes within the midgut and the pouch of the hindgut (Shannon et al. 2001; Sauer et al. 2002; van Borm et al. 2002a; Li et al. 2005). These symbiotic microbiota are members of Alpha, Beta, and Gamma divisions of Proteobacteria, as well as Flavobacteria (van Borm et al. 2002a), and including a novel candidate genus, *Blochmannia* (Sauer et al. 2000; Sauer et al. 2002). Classification of these microbes was accomplished by culture-independent methods as these bacteria often cannot be cultured outside of their hosts (Schroder et al. 1996). In addition, media for culturing has typically been developed for medical studies and the growth conditions for fastidious microorganisms are often lacking, leading to misrepresentative sampling of the gut microbiota (Dillon and Dillon 2003). To surmount these difficulties, sequence analysis of 16S ribosomal DNA (rDNA) has become widely accepted as a tool

for investigating unculturable microbes in these often complex communities (Hongoh et al. 2003a, b).

This manuscript represents the first preliminarily analysis of the gut microbiota of a diprionid species. PCR was used to amplify bacterial 16S ribosomal DNA (rDNA), extracted from excised larval guts, and along with Denaturing Gradient Gel Electrophoresis (DGGE) revealed 4 distinct DNA products. BLAST-n analysis and comparison rank searches of the Ribosomal Database Project II (RDP II) database showed similarity to Alphaproteobacteria and Gammaproteobacteria. Maximum parsimony and neighbour joining analyses confirmed these observations.

Materials and Methods

Larval collection

Balsam fir branches, containing *Neodiprion abietis* larvae, were collected from forest stands near Old Man's Pond (near Corner Brook), Newfoundland, Canada (N 49° 05"59' W 57° 56"05'). Larvae were maintained on balsam fir in paper bags at 4°C. Head capsule widths of healthy larvae were measured using a dissecting microscope with a calibrated objective. Larvae with head-capsule widths between 0.68-1.4 mm, corresponding to 2nd to 4th instar larvae, were harvested for histological preparation and extraction of total DNA from the excised gut.

PCR amplification, DGGE, and sequencing of bacterial *16S* gene

Larvae harvested for molecular characterization of sawfly-gut bacteria were surface sterilized with a 60 second wash in 5% bleach, followed by a 60 second rinse in DEPC-treated water (0.1% diethyl pyrocarbonate). Larvae were submerged in sterile phosphate buffered saline (PBS, pH 7.4), and anterior and posterior segments were excised just posterior of the head capsule and immediately anterior to the eighth proleg, respectively. The cuticle was secured and the gut was pulled from the body cavity. The excised gut was transferred to fresh PBS and the peritrophic membrane, containing the food bolus, was pulled from the gut lumen using forceps. The gut tissue was immediately placed into RNAlater (Ambion Inc., Austin, Texas) and stored at -20°C.

DNA was purified using TRIzol (Invitrogen Co., Burlington, Ontario), following the manufacturer's protocol. Two primer sets were used to ensure amplification of the targeted bacterial 16S rDNA. Primers p984f-GC (5'-CGCCCGGGGCGCGCCCCGGGCGGGGCGG GGGCACGGGGGGAACGCGCCGAACCTTAC-3') and p1401r (5'-GCGTGTGT ACAAGACCC-3') were used to amplify the V6 to V8 regions of 16S ribosomal DNA (Nòbel et al. 1996; Frederick and Caesar 2000). Primers p515f-GC (5'-CGCCC GGGGCGCGCCCCGGGCGGGGCGGGGGCACGGGGGGCCAGCAGCCGCGGTAA -3') and p806r (5'-GGACTACCAGGGTATCTAAT-3') were used to amplify the variable V4 region of 16S rDNA (Relman 1993). PCR mixtures of 50 µl volume contained reaction buffer (10 mM Tris-HCl pH 8.3 at 25°C, 50 mM KCl, 1.5 mM MgCl, 0.001% gelatin), 10 µM each of dATP, dTTP, dCTP, and dGTP, 0.1 µM of each primer, 1 unit *Taq* polymerase (Qiagen, Mississauga, Ontario) and approximately 10 ng insect genomic DNA template. PCR was conducted using a Mastercycler EP thermal cycler (Eppendorf, Mississauga,

Ontario), with the following settings: (i) 94°C for 5 min, 1 cycle; (ii) 94°C for 30 sec, 52°C for 30 sec, 72°C for 45 sec, 40 cycles; (iii) 72°C for 5 min, 1 cycle. On completion of thermal cycling, 10% of the reaction was loaded on a 1% agarose gel and electrophoresed in 1X TBE buffer (90 mM Tris Borate, pH 8.3, 2 mM EDTA) for 2 hrs at 60 V. The gel was stained with ethidium bromide and visualised using UV illumination.

Subsequently, the PCR products (50% of the reaction) were separated by DGGE using the DCode system (BioRad) according to the manufacturer's instructions. Gels consisted of 1 mm thick 6% polyacrylamide with a denaturing gradient of 30-70 % (100% denaturant corresponds to 7 M urea and 40 % vol/vol deionized formamide) and 1X TAE buffer (90 mM Tris Acetate, pH 8.3, 2 mM EDTA) for 16 hours. Electrophoresis was performed at 60°C and 80 V in 1X TAE running buffer for 16 hours. Gels were stained with SYBR Gold nucleic acid stain (Invitrogen) for 30 minutes and images captured upon UV illumination. DNA bands were excised with a sterile razor blade and placed in 100 μl of sterile distilled H_2O. The samples were placed at 94°C for 5 minutes to elute the DNA from the polyacrylamide and were stored at 4°C overnight. Five μL of the supernatant were used as template to reamplify the individual DNA bands. The PCR conditions were the same as above, but with only 30 cycles of amplification. The PCR products were gel purified using the QIAquick Gel Extraction Kit (Qiagen), and samples stored at -20°C until ready for sequencing. Sequencing was performed by Ontario Genomics Innovation Centre, using an ABI 3730 DNA Analyzer (BigDye version 3.1).

Sequence data was analysed using BLAST-n (http://www.ncbi.nlm.nih.gov/BLAST) and the Similarity Rank program of the RDP II (http://rdp.cme.msu.edu/seqmatch/seqmatch_intro.jsp) (Maidak et al. 1999), to determine similarity with known bacterial species (in the database). Closely related species, as well as gut microbiota listed in recent publications (Boursaux-Eude and Gross 2000; Sauer et al. 2000; Shannon et al. 2001; van Borm et al. 2002b; Hongoh et al. 2005), were used to construct phylogenetic trees using neighbour joining and maximum parsimony algorithms, with 1000 bootstrap replicates. Phylogenetic and molecular evolutionary analyses were conducted using MEGA version 3.1 (Kumar et al. 2004).

Results

DGGE separated four 16S rDNA fragments when using the p984f-p1401r primer set (Table 1, #1 to 4), and two fragments after amplification from the p515f-p806r primer set (Table 1, #5 and 6). BLAST-n analysis and similarity rank comparisons to the RDP II sequence database predicted four bacteria matches: *Rahnella* sp. (sequence #1, GenBank Accession No. EF140875), *Yersinia* sp. (sequences #2-4, GenBank Accession No. EF140876-EF140878), an Enterobacteriaceae (sequence #5, GenBank Accession No. EF140880), and an Alphaproteobacteria (sequence #6, GenBank Accession No. EF140879).

Phylogenetic analysis confirmed the predicted identities of the first four bacteria and showed their close relationship to other known insect-gut microbes in the Enterobacteriaceae family of Gammaproteobacteria. Maximum parsimony and neighbor joining analyses suggest that sequence #1 was most closely related to *Rahnella aquatilis*. Both analyses weakly supported the clustering of sequences #2-4 with *Yersinia*, with the degree of their

TABLE 1. Highest NCBI BLAST-n[1] results and RDP II comparison values[2] (from GenBank and the RDP II databases) for portions of 16S ribosomal DNA sequences obtained from DNA extracted from the microbiota of *Neodiprion abietis* larval-midguts (after amplification by PCR and separation by DGGE).

DGGE fragment (primer set)	Amplicon size (bp)	Predicted Identity	Blast Match Accession Number (% identity)	RDP (% identity)
#1 (p984f-GC/p1401r)	318	*Rahnella* sp.	U90758 (99%), DQ440548 (97%)	S000438772 (96.5%), S000653581 (96.5%)
#2 (p984f-GC/p1401r)	321	*Yersinia* sp.	AJ627599 (99%), AJ627600 (99%)	S000539482 (94.6%), S000539483 (94.6%)
#3 (p984f-GC/p1401r)	314	*Yersinia* sp.	AJ627599 (99%), AJ627600 (99%)	S000539482 (95.3%), S000539483 (95.3%)
#4 (p984f-GC/p1401r)	308	*Yersinia* sp.	AJ627599 (99%), AJ627600 (99%)	S000539482 (100%), S000539483 (100%)
#5 (p515f-GC/p806r)	180	Enterobacteriaceae sp.	AY859722 (97%) U93263 (97%) DQ440548 (97%)	S000015297 (100%), S000497099 (100%)
#6 (p515f-GC/p806r)	184	Uncultured Alphaproteobacterium	AJ459874 (100%), DQ163946 (100%)	S000093253 (100%), S000600168 (100%)

[1] NCBI BLAST website:http://www.ncbi.nlm.nih.gov/BLAST

[2] RDP II website: http://rdp.cme.msu.edu/seqmatch/seqmatch_intro.jsp

A

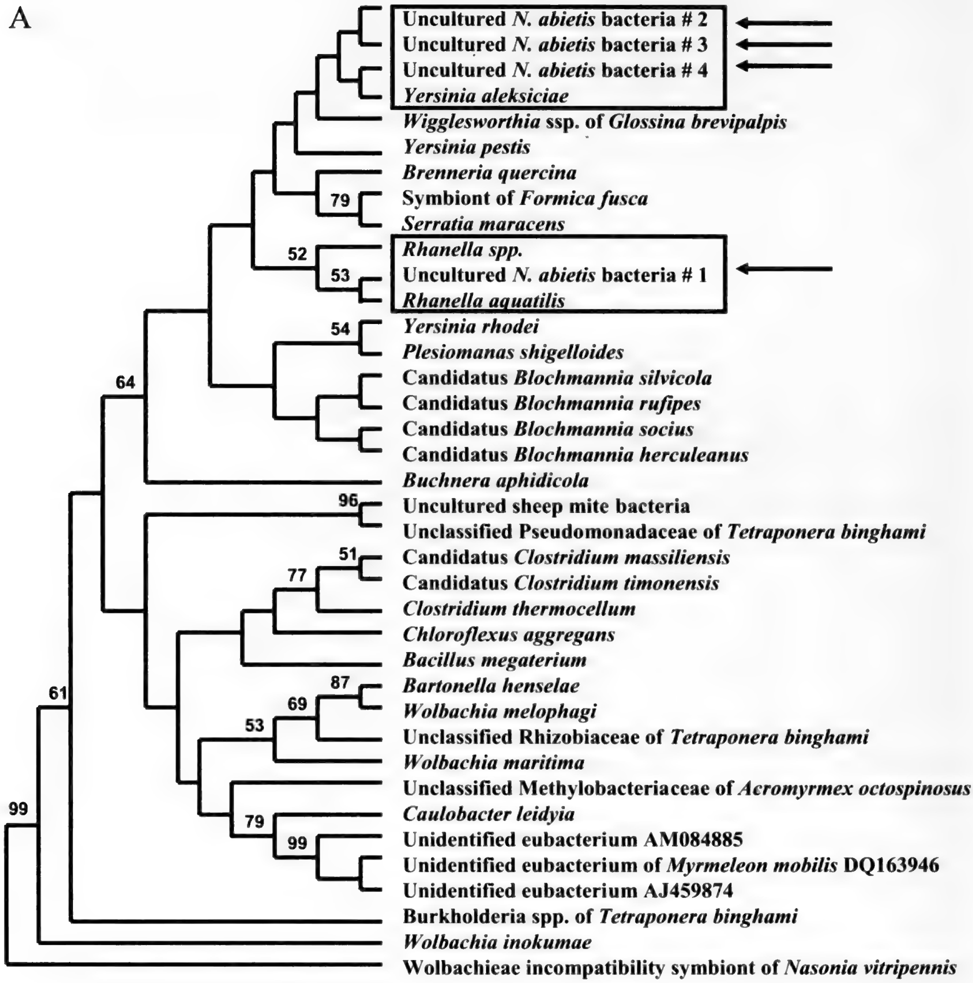

FIGURE 1. Phylogenetic analyses of bacterial 16S ribosomal DNA gene sequences amplified from insect guts. Maximum parsimony (A and C) and neighbour joining trees (B and D) were inferred using the Mega 3.1 program with 1000 bootstrap repetitions. Support values >50% are listed at nodes. Sequences of 16S ribosomal DNA from the microbiota of *N. abietis* larval guts are indicated with arrows. Bacteria identified by sequences #1–4 (from primer set p984f-GC/p1401r) are represented in Trees A and B, while bacteria identified by sequences #5 and #6 (primer set p515f-GC /p806r) are represented in Trees C and D. Boxes indicate groups referred to in Table 1.

B

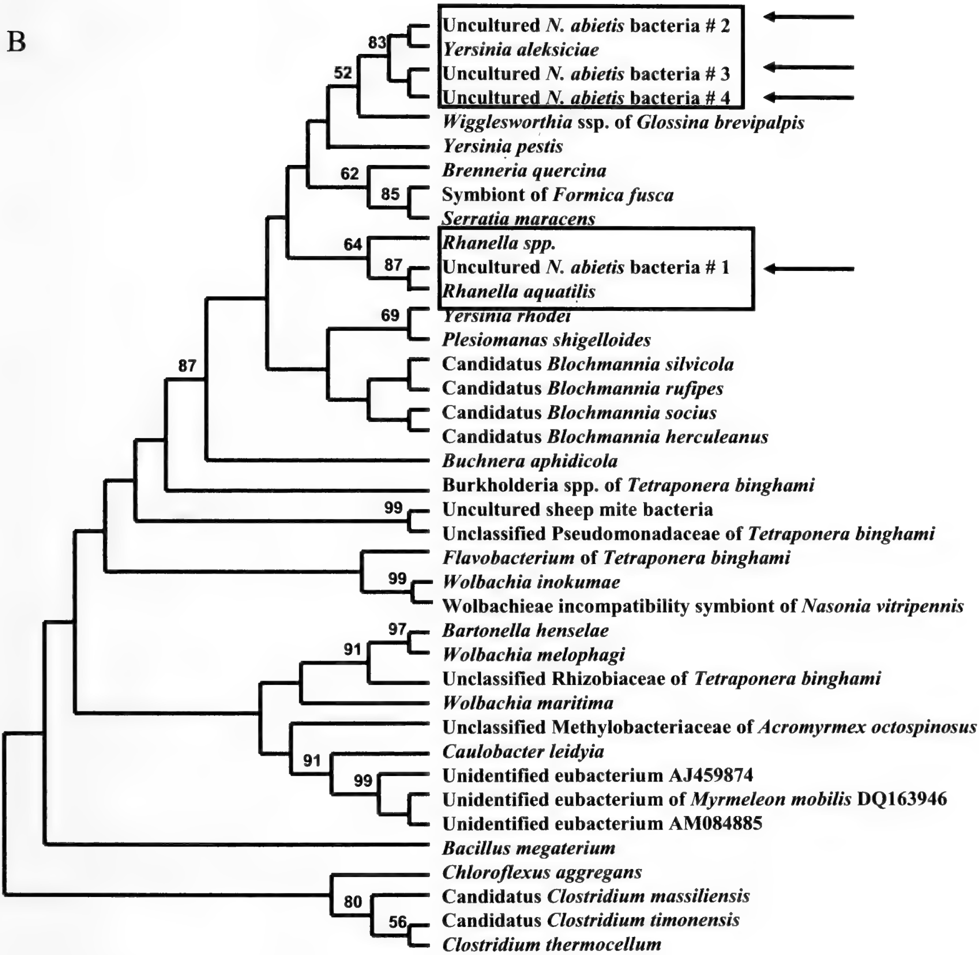

FIGURE 1. Continued

C

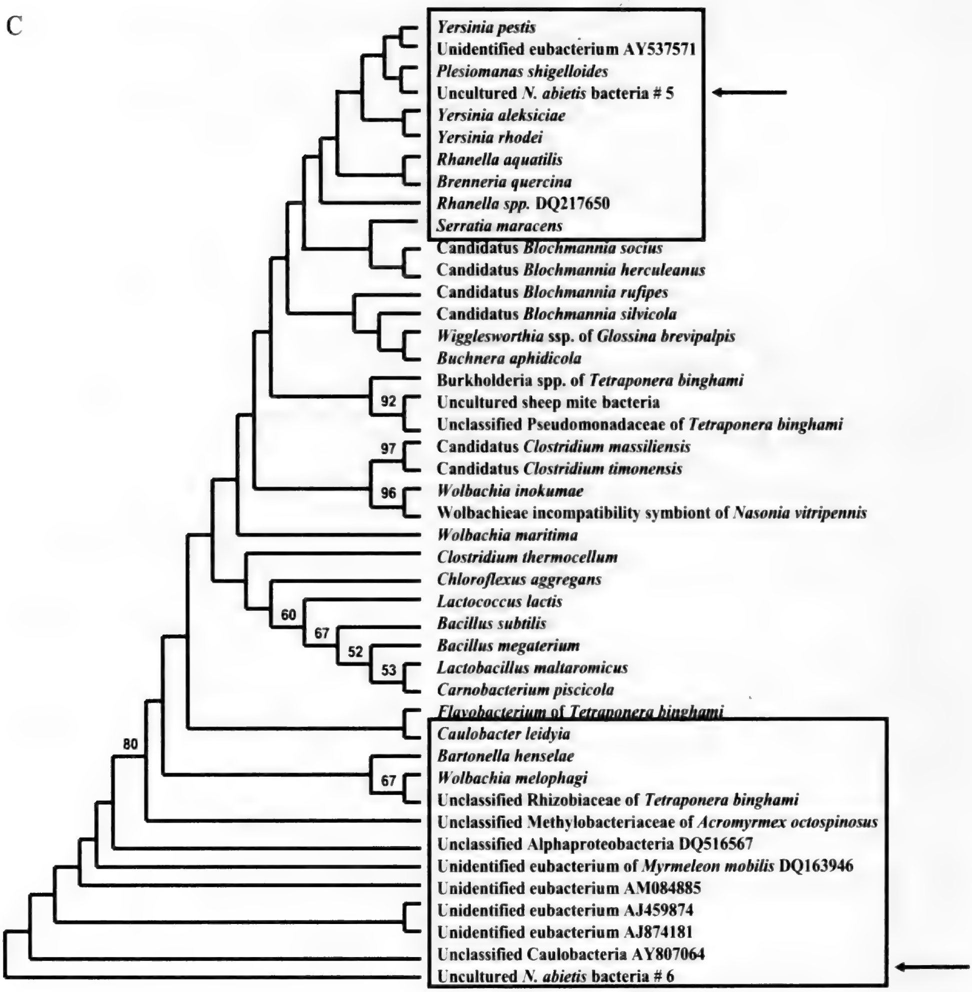

FIGURE 1. Continued

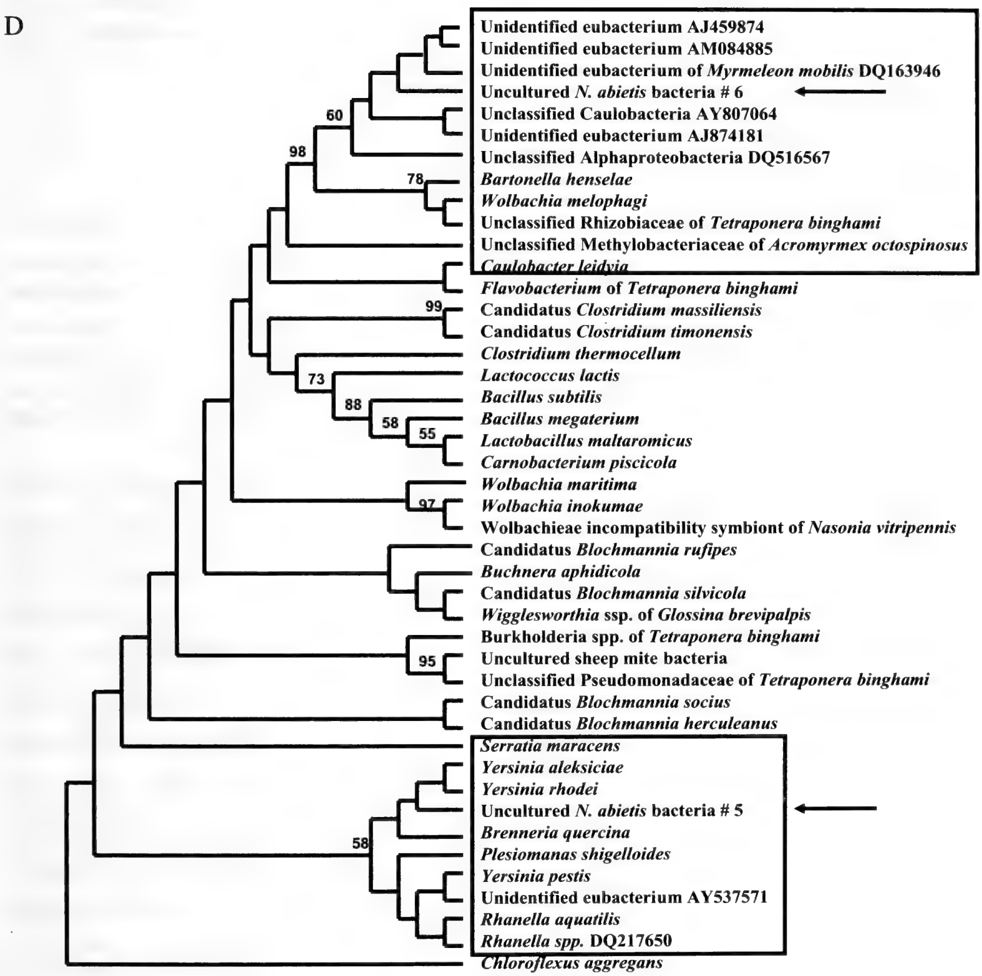

FIGURE 1. Continued

relatedness to *Yersinia aleksiciae* varying (Table 1 and Figure 1). The three 16S rDNA sequences showed 98.7% identity to each other and were approximately 320 bp in length.

The identity of the bacterium from which sequence #5 was derived was not determined beyond Enterobacteriaceae because results from maximum parsimony and neighbor joining analyses were inconsistent. The difficulty in confirming the identity of this bacterium may be a result of the small amplicon size (180 bp). However, sequence #6 (184 bp), which was amplified with the same primer set, clearly clustered with the Alphaproteobacteriaceae. Maximum parsimony analysis suggested that bacteria, from which sequence #6 was derived, belonged to the genus *Caulobacter.*

Discussion

The microbiota identified by 16S rDNA sequences from *N. abietis* gut tissues include those that have been found ubiquitously in the environment and likely originated from the host's diet (Selenska-Pobell et al. 1995; Dillon and Charnley 2002; Sprague and Neubauer 2005). Similarly, other free-living microbial species have been isolated from other sawfly gut tissues, including *Pristiphora geniculata*, *Acantholyda erythrocephala*, and *Pikonema alaskensis* (R. Graham, unpublished data). Fragments #1-5 (based on 16S rDNA sequences) represent bacteria that belong to the Gammaproteobacteria, specifically those in the Enterobacteriaceae family of Gram-negative, anaerobic microbes.

Neither *Rahnella aquatilis* nor *Yersinia aleksiciae* have been published as insect gut microbes, although *R. aquatilis* has been isolated from both chicken ticks (Montasser 2005) and the intestinal contents of snails (Brenner et al. 1998). An uncultured *Rahnella* sp. was reported in GenBank (Accession # U84730) from an isolate of the microbial gut flora from the coleopteran genera *Phaleria* and *Latreille* (Tenebrionidae). *Rahnella* spp. have been isolated from foliage (Hashidoko et al. 2002; Izumi et al. 2006) and ferment several polysaccharides (Brenner et al. 1998). Additionally, *Rahnella* spp. have been recognized as strong nitrogen fixers (Brenner et al. 1998; Izumi et al. 2006). This characteristic would be important for nitrogen recycling in nutrient-poor diets and possibly promote its retention as a symbiont within the gut, perhaps originally acquired through the sawfly's diet.

Species of *Yersinia* have been isolated from other insect guts (Ulrich et al. 1981); therefore it is not surprising that we found related bacteria in the gut of *N. abietis.* No beneficial characteristics have been attributed to *Yersinia.* Their ubiquitous presence in soils and detritus suggest that this bacterium is more likely to be a transient microbe ingested with food matter, rather than part of the permanent flora of the sawfly gut.

16S-sequence analysis of fragment #5 and subsequent phylogenetic comparisons to other Gammaproteobacteria was inconsistent and poorly resolved. Maximum parsimony indicated that the closest relative to the *N. abietis* bacteria was *Plesiomanas shigelloides*, while neighbour joining analysis suggested that *Y. rhodei* was more closely related. BLAST-n searches of the 16S ribosomal sequence commonly aligned *Serratia* spp. with high degrees of identity (97%). *Yersinia, Rahnella,* and *Serratia* spp. have been shown to cluster closely together in a Group B of the enterobacterial genera, with the main signature nucleotides located between positions 590-649 (Sproer et al. 1999). The p515f-p806r primer set amplifies the variable V4 region of 16S rDNA between base pairs 627 and 807. This

region only overlaps the signature nucleotides by 22 bp, making a positive identification difficult. Therefore bacterial sequence #5 can only be classified as an Enterobacteriaceae until further data is collected.

Finally, 16S-sequence analyses indicated that bacterium #6 was a member of the Alphaproteobacteria, showing high similarity with uncultured bacteria of insect larvae and soil (GenBank AJ459874, DQ163946, and AM084885; Table 1; Figure 1 C, D). An uncultured *Caulobacter* (GenBank AY807064) aligned within the unidentified Alphaproteobacteria, supported by a 98% bootstrap value, suggesting that the *N. abietis* bacterium #6 may be Caulobacter-like. Although Caulobacteria have typically been isolated from aquatic environments, a few isolates have been reported from the intestinal contents of a millipede (Abraham et al. 1999) and the mite *Tetranychus urticae* (Hoy and Jeyaprakash 2005). If *N. abietis* bacterium #6 is a *Caulobacter*, this microbe may play a key role in nutrient acquisition since Caulobacteria have been shown to uptake phosphorus from nutrient-poor environments (Gonin et al. 2000). Chemical analyses of current year foliar nutrients have reported phosphorous levels at 900-4000 ppm along the eastern US coastline and in the Laurentide-Onatcheway region of Québec, Canada (Bauce et al. 1994; Richardson 2004). Although foliar chemical data for balsam fir growing in Newfoundland could not be found, it is known that phosphorous levels decline rapidly in trees growing in harsh conditions (Richardson 2004). Due to the often severe climate of Newfoundland, one would predict phosphorous levels at the lower end of the range reported.

The diversity of the gut microbiota of *N.* abietis, using a PCR prospecting approach, is relatively low compared to the variety of microbes observed in termite and cockroach guts (Cruden and Markovetz 1984; Hongoh et al. 2003a). Approximately 270 phylotypes have been detected in the gut of *Reticulitermes speratus* and the bacteria were classified into 9 of the 20 phyla of eubacteria (Hongoh et al. 2003a). In contrast, only 6 phylotypes were detected in *N. abietis* and were classified within a single eubacterial phylum (Proteobacteria).

Although low levels of bacterial diversity within insect guts are not uncommon, the microbiota are generally composed of multiple phyla. The gut of the gypsy moth, *Lymantria dispar* (Order Lepidoptera) has a microbial diversity that ranges from 7 to 15 phylotypes, depending on its diet source (Broderick et al. 2004). A total of 13 genera were identified from larvae feeding on all diet sources and were classified within the Actinobacteria, the Bacteroidetes/Chlorobi group, Firmicutes, and Proteobacteria. Similar results were obtained from cultured isolates and 16S sequence analysis of microbes detected within the midgut of *Culex quinquefasciatus* (Order Diptera), where bacteria from 13 genera were identified (Pidiyar et al. 2004). The majority of mosquito bacteria belonged to the Gammaproteobacteria class (60% of cultured and 46% of culture-independent), while Actinobacteria and Firmicutes constituted the remainder of the bacterial types.

While diet influences the acquisition of bacterial flora observed in insect guts, morphology is often a significant factor affecting the diversity of the gut microbiota. Many termites and cockroaches have evolved complex and convoluted guts (Wigglesworth 1972; Brune and Friedrich 2000) that allow the retention of bacteria in specialized fermentation structures. Insects possessing simple and straight alimentary canals, such as the Diprionidae, Lepidoptera, and many Diptera, generally have a lower diversity of gut microbes (Dillon and Dillon 2003). Due to the selective diet of *N. abietis* and the simple morphology of its gut, the low level of bacterial diversity is not unexpected.

Nonetheless, 16S rDNA sequencing and phylogenetic analyses identified six phylotypes in the larval gut of the balsam fir sawfly; four of the bacteria were clustered with *Rahnella sp.* and *Yersinia sp.*, while the other two bacteria were determined to belong to the Enterobacteriaceae and Caulobacteriaceae. Whether or not they are present as obligate endobionts, they may variously play significant roles as associated microflora in sawfly larvae.

Acknowledgements

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REVISION OF THE NORTH AMERICAN *SOBAROCEPHALA* (DIPTERA: CLUSIIDAE, SOBAROCEPHALINAE)

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Abstract *J. ent. Soc. Ont.* 138: 65–106

The 17 species of *Sobarocephala* Czerny, 1903 occurring in the Neartic north of Mexico are reviewed and keyed. *Sobarocephala wirthi* spec. nov. and *S. pengellyi* spec. nov. are described from the eastern United States. Descriptions, illustrations, and distribution maps are provided for all Nearctic species.

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Introduction

Sobarocephala Czerny, 1903, as redefined by Lonsdale and Marshall (2006), is a large, predominantly neotropical genus with 17 Nearctic species and at least a dozen described and undescribed species from the Afrotropical, Australian, and Oriental Regions. The Nearctic species do not form a monophyletic group, but instead belong to a number of independent lineages, several of which are tropical in origin. The North American fauna, including two new eastern species allied to *S. latifrons* (Loew), is here revised.

North American *Sobarocephala* species are small (2.4-5.6 mm), thin, pale yellow flies, often with distinctive brown patterning. Two male genitalic characters define the genus (a basal shield on the distiphallus and a "thumb" on the lateral lobe of the distiphallus (Lonsdale and Marshall 2006)), but *Sobarocephala* is most easily separated from other Nearctic Clusiidae by the absence of interfrontal bristles (found in *Clusiodes* Coquillett, 1904 and *Clusia* Haliday, 1838), the possession of inclinate anterior fronto-orbital bristles (reclinate in *Clusiodes* and *Craspedochaeta* Czerny, 1903), and the presence of a well-developed dorsal preapical bristle on the mid tibia (absent in *Clusia* and *Heteromeringia* Czerny, 1903). A key to the North American genera of Clusiidae was provided in Soós (1987); we follow Woodley (1984) in treating the single Nearctic *Chaetoclusia* (*C. affinis* Johnson) identified in that key as *Sobarocephala*.

Although the Nearctic *Sobarocephala* were recently treated by Sabrosky and Steyskal (1974), considerable new material has become available since then, allowing us

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to reconsider the Nearctic fauna on the basis of over 1200 specimens. We here add two species to the genus, provide an updated key, list new distributional data, and draw attention to previously unrecognized sister-group relationships.

Materials and Methods

Material from the following institutions was examined for this revision: California Academy of Sciences, San Francisco (CASC); Carnegie Museum of Natural History, Pittsburgh (CMNH); Canadian National Collection, Ottawa (CNCI); University of Guelph Insect Collection, Guelph (DEBU); Entomological Museum of Utah State, Logan (EMUS); Instituto Nacional de Biodiversidad, Santo Domingo de Heredia (INBC); Museum of Comparative Zoology, Cambridge (MCZC); North Carolina State University, Raleigh (NCSU); Texas A&M University, College Station (TAMU); Tel Aviv University, Tel Aviv (TAUI); United States National Museum, Washington, D.C. (USNM).

Specimen preparation and terminology follows that in Lonsdale and Marshall (2006). The M_{1+2} ratio is defined as the length of the ultimate section of vein M divided by the length of the penultimate section. Size ranges include both sexes. Label data for non-type material is not listed for the relatively abundant *S. flaviseta* (Johnson), *S. latifacies* Sabrosky & Steyskal, and *S. latifrons* (Loew). Maps only include Nearctic records.

Generic Diagnosis

Pedicel with pronounced outer and inner angulate extensions. Cell bm open or closed. Interfrontal bristle absent. Anterior fronto-orbital bristle inclinate. Vein R_1 bare dorsally. Thorax usually with two postsutural dorsocentral bristles (rarely one or three in some tropical species). Presutural intra-alar bristle absent or weak in Nearctic species. Mid tibia with preapical dorsal bristle. Male 6th spiracle moved into membranous region anterior to annulus. Ventrolateral lobe of hypandrium setose and relatively large. Distiphallus almost always with basal shield (present in all Nearctic species); lateral lobe of distiphallus often with "thumb" (Fig. 20).

Key to the species of *Sobarocephala* north of Mexico

1. Arista densely plumose (Figs. 1, 2, 6, 7). Bristles usually yellow. Gena usually shiny. First flagellomere with dorsal stripe or spot around base of arista 2
– Arista sparsely plumose or pubescent (Figs. 3–5). Bristles light brown to black. Gena pilose to silvery tomentose. First flagellomere entirely yellow dorsally (*S. texensis* and some *S. setipes* with light infuscation around base of arista and *S. flava* females with anterior margin lightly pigmented) 5
2. Ocellar bristles minute to absent. Scutum with two pairs of spots; scutellum brown, at least in part. Sides of frons converging posteriorly. Female tergite 8 yellow. Surstylus with tubercle–like bristles apical. Southern United States 3

– Ocellar bristles well-developed. Scutum and scutellum yellow. Sides of frons parallel. Female with basal half of tergite 8 brown. Surstylus with tubercle-like bristles along length of distal and posterior margins. Eastern United States 4

3. Scutellum, laterotergites, and epandrium entirely brown (Fig. 1). Gena shiny. Cerci flush with distal margin of epandrium (Fig. 28). Surstylus subrectangular with long palisade-like bristles along inner-distal margin (Figs. 27, 28). Distiphallus large and spoon-shaped; lateral lobe without thumb (Fig. 29). Southeastern United States, Central America, Bahamas, Colombia ....*S. quadrimaculata* Soós

– Scutellum brown laterally (Fig. 2), laterotergites brown lateral to scutellum, and epandrium yellow. Gena silvery tomentose. Cerci projecting (Fig. 25). Surstylus triangular with apical tubercle-like bristles (Figs. 24, 25). Distiphallus relatively small and thin; lateral lobe with thumb (Fig. 26). Florida ....*S. cruciger* Sabrosky & Steyskal

4. Bristles and epandrium yellow (Fig. 6). Wing clear. Hind tibia and tarsi yellow. Frons yellow. Occiput occasionally pilose. Eastern United States ....*S. affinis* (Johnson)

– Bristles and epandrium brown (Fig. 7). Wing very lightly clouded on distal 1/3 along R_{2+3}. Hind tibia and tarsi sometimes brownish. Frons sometimes with anterior margin white. Occiput usually pilose. Eastern and southeastern United States ....*S. muesebecki* Sabrosky & Steyskal

5. Sides of frons converging posteriorly. Notopleuron and/or scutellum sometimes with white markings 6

– Sides of frons parallel. Neither notopleuron nor scutellum with white spots 8

6. Scutellum white. Scutum with brown supra-alar spot and basal quadrate stripe; notopleuron, postpronotum, and posterolateral scutal spots white (Fig. 5). Arista pubescent. Florida, Dominican Republic ....*S. atrifacies* Sabrosky & Steyskal

– Scutellum yellow. Scutum predominantly yellow, sometimes with brown markings; white markings, if present, restricted to notopleuron and postpronotum (Fig. 3). Arista short-plumose 7

7. Bristles brown. Cell bm closed. Notum yellow with notopleuron and postpronotum white, at least in part (Fig. 3). Fore tarsi yellow. Female abdomen yellow with thin central stripe on tergite 3 and with wide light brown stripe (narrowing anteriorly) on tergites 4 and 5. Tubercle-like bristles on surstylus confined to apex (Fig. 19). Widespread in North America ....*S. flaviseta* (Johnson)

– Bristles black. Cell bm open. Notum yellow, sometimes with lateral margin brown (Fig. 4). Fore tarsi light brown, at least apically. Female abdominal tergites 2-5 with small brown anteromedial spot; tergites 6 and 7 dark brown. Tubercle-like bristles on surstylus extending onto posterior margin (Fig. 22). Northeastern North America and Utah ....*S. latifacies* Sabrosky & Steyskal

8. Scutellum entirely brown (Fig. 14). Frons sometimes with orange tint (darkest posteriorly). Scutum with one pair of wide postsutural stripes (connected posteriorly). Eastern North America ....*S. dreisbachi* Sabrosky & Steyskal

– Scutellum yellow, at least in part. Frons yellow. Pattern on scutum variable 9

9. Scutellum usually with central brown stripe (sometimes only brown medially or apically), but if yellow with distal infuscation on ventromedial surface, then surstylus

hook-shaped (some *S. latifrons*; Fig. 48) or subtriangular (some *S. wirthi*; Fig. 45) 10
– Scutellum entirely yellow or brown laterally; never yellow with ventromedial infuscation. Surstylus broadly rounded or bifid, but never hook-like or triangular 14

10. Stripe on scutellum darkest at midpoint (Figs. 15, 17). Acrostichal bristle absent. Female tergite 2 with wide central stripe. Male abdomen with wide central stripe on tergites 2-5. Male sternite 5 with posteromedial comb of bristles. Surstylus small, lobate, and without tubercle-like bristles (Fig. 60) 11
– Stripe on scutellum evenly brown or darkest at apex (Fig. 10). Acrostichal bristle present. Female tergite 2 brown along posterior margin or with thin central stripe. Male abdomen entirely yellow or with variable light brown pattern. Male sternite 5 without comb. Surstylus at least 2/3 length of epandrium with tubercle-like bristles along distal 2/3 of posterior margin (Fig. 43) 12

11. Scutum yellow with one pair of brown spots on notopleuron and (usually) one pair of postsutural stripes (Fig. 15). First flagellomere yellow. Bristles light brown. Fore tibia yellow. Occiput pilose. Small bristle in front of anterior dorsocentral. Female tergite 6 with wide central stripe. Laterotergites sometimes brown laterally. Distiphallus short, and lateral lobe small and ovate (Fig. 61). Eastern North America north to Ottawa ....*S. setipes* Melander & Argo (in part)
– Scutum yellow, sometimes with light brown prescutellar spot extending onto scutellum (Fig. 17). First flagellomere with light infuscation around base of arista. Bristles brown. Fore tibia light brown. Occiput shiny. No small bristle in front of anterior dorsocentral. Female tergite 6 yellow. Laterotergites yellow. Distiphallus longer than half length of phallapodeme, and lateral lobe well-developed (Fig. 58). Texas ....*S. texensis* Sabrosky & Steyskal

12. Bristles light brown. Scutum with light brown lateral markings (Fig. 12). Male face light brown medially and female face sometimes orange medially. Epandrium dark brown. Surstylus small, rounded, and 2/3 length of epandrium (Fig. 42). Female tergite 6 brown, and tergites 2-4 yellow except for thin central brown stripe. Alabama, Georgia ....*S. pengellyi* spec. nov.
– Bristles dark brown to black. Scutum with variable lateral markings. Face yellow in both sexes. Epandrium predominantly or entirely yellow. Surstylus almost as long as epandrium. Female tergite 6 brown laterally and (sometimes) basally, and tergites 2-4 dark laterally (sometimes also dark medially). Eastern United States 13

13. Surstylus hook-shaped (Fig. 48). Female abdomen sometimes with central brown stripe in addition to lateral markings (Fig. 10). Epandrium sometimes with small basal spot ....*S. latifrons* (Loew)
– Surstylus broad and rounded apically (Fig. 45). Female abdomen yellow medially (Fig. 11). Epandrium entirely yellow ....*S. wirthi* spec. nov.

14. Female abdomen mostly or entirely yellow on tergites 1-5 and dark brown on tergite 6. Male abdomen entirely yellow and gena thin (height less than half that of first flagellomere). Surstylus large, lobate, and widest distally. Male cerci rounded and slightly projecting 15

– Female abdomen with wide central stripe on tergites (2) 3-6 (interrupted on tergite 5 in some *S. lachnosternum* and on tergite 6 in *S. interrupta*). Male abdomen with wide central stripe, but if entirely yellow, gena as high as first flagellomere. Surstylus less than half length of epandrium, small, and rounded or bifid. Male cerci flush with distal margin of epandrium or sunken 16

15. First flagellomere yellow in both sexes, with anterior margin lightly infuscated in females (Fig. 8). Wing lightly (sometimes indistinctly) clouded along R_{2+3} and costa (darkest distally). Female laterotergites yellow. Eastern United States, Texas, Utah ....*S. flava* Melander & Argo

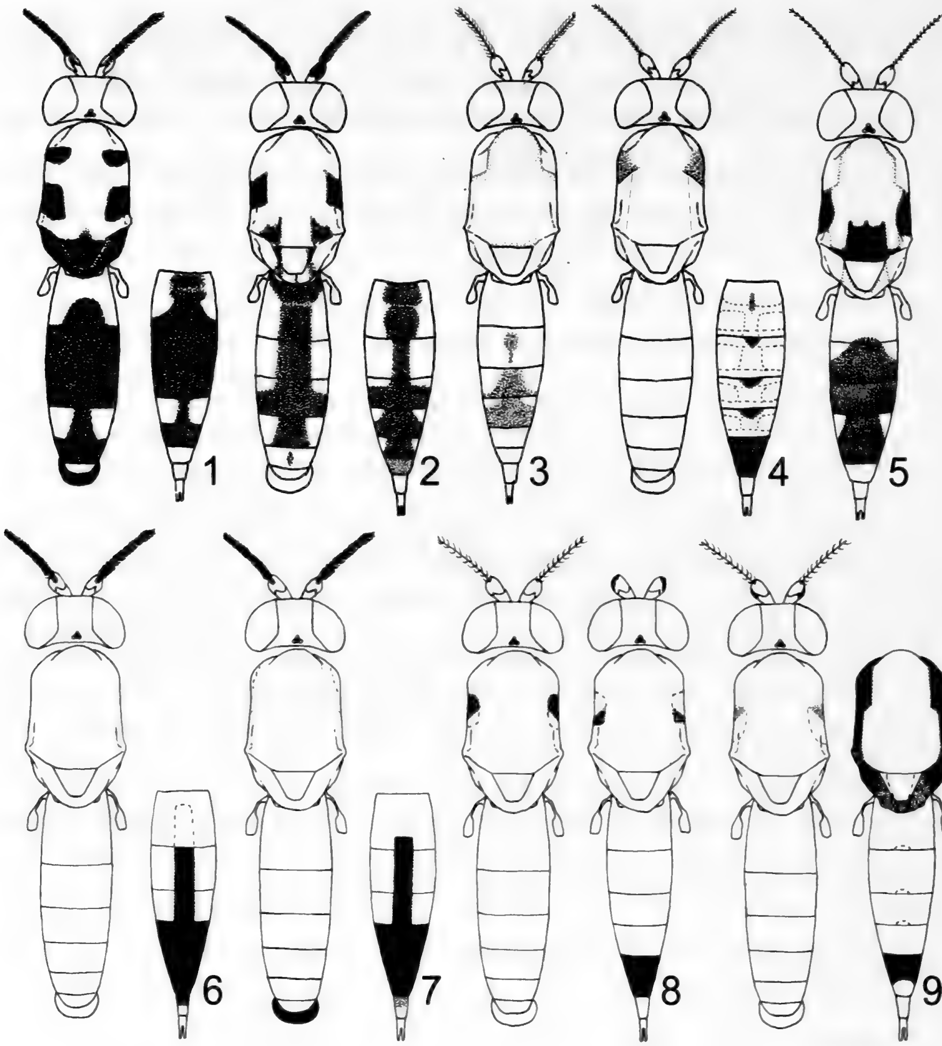
– First flagellomere dark brown to black on ventral half (Fig. 9). Wing clear. Female laterotergites brown, at least in part. Northeastern North America, Kansas ....*S. atricornis* Sabrosky & Steyskal

16. Postsutural stripe serrate on anterior margin. Scutellum brown laterally (rarely yellow) (Fig. 13). Female tergite 6 yellow, sometimes with anteromedial spot. No small bristle in front of anterior dorsocentral. Anterior lateral scutellar bristle minute or absent. Surstylus bifid (Fig. 51). Male cerci flush with distal margin of epandrium (Fig. 52). Posterior margin of male sternite 5 without posteromedial comb. Southeastern United States, Illinois ....*S. interrupta* Sabrosky & Steyskal

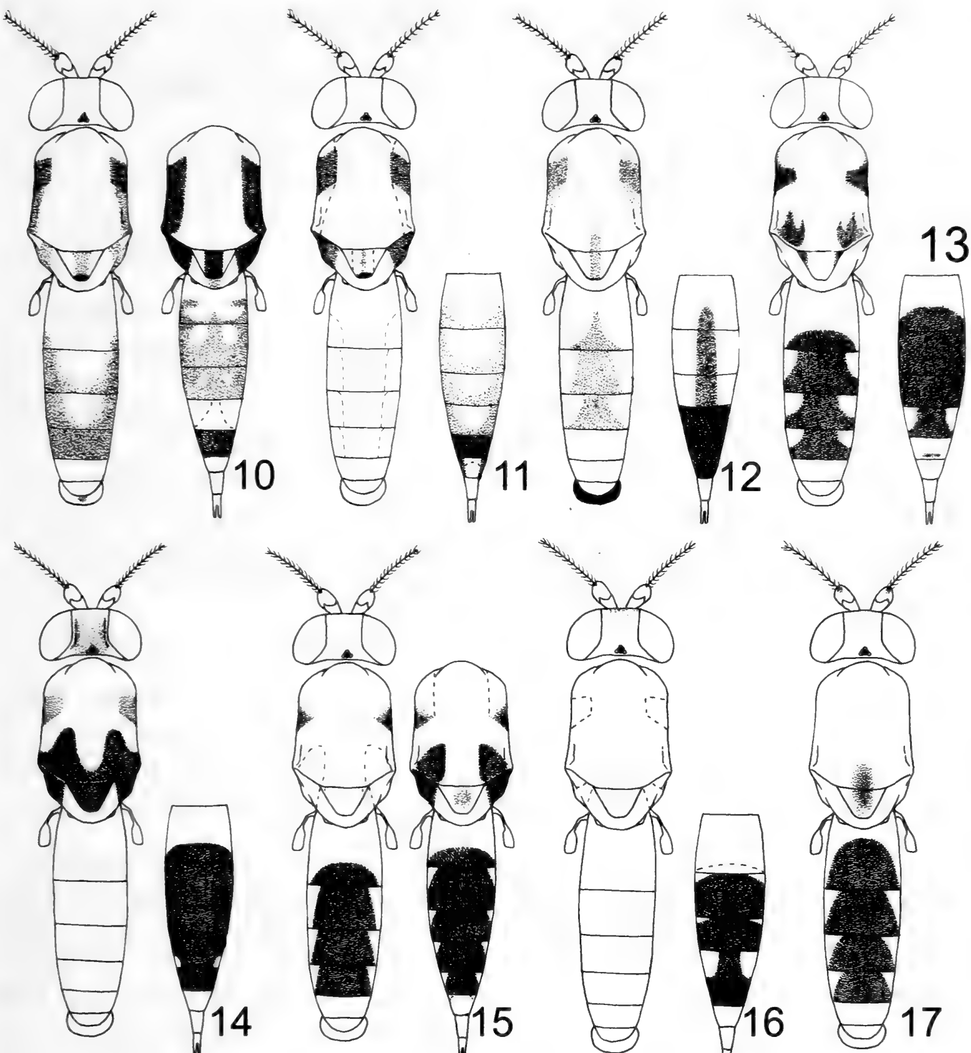
– Postsutural stripe entire and rounded on anterior margin, if present. Scutellum usually yellow, but if lateral corner brown (some *S. setipes*), small bristle present in front of anterior dorsocentral. Female tergite 6 brown, at least medially. Anterior lateral scutellar bristle not much smaller than posterior bristle, if at all. Surstylus rounded. Male cerci sunken below distal margin of epandrium. Male sternite 5 with posteromedial comb 17

17. Notopleuron brown posteriorly (females sometimes with most of notopleuron and postpronotum brown) and scutum with one pair of wide brown postsutural stripes (Fig. 15). Acrostichal bristle absent. Length 2.4-2.9 mm. Female abdomen with wide brown stripe on tergites 2-6. Eastern North America ....*S. setipes* Melander & Argo (in part)

– Scutum yellow with dark brown quadrate spot on notopleuron (sometimes faded in males and teneral specimens) (Fig. 16). Acrostichal bristle present. Length 3.9-4.9 mm. Female abdominal pattern as follows: tergite 2 sometimes brown along posterior margin, tergites 3 and 4 with wide central stripe, tergite 5 with narrow central stripe, and tergite 6 dark brown. Eastern and central North America ....*S. lachnosternum* Melander & Argo



FIGURES 1–9. 1–*Sobarocephala quadrimaculata* Soós; male (left) and female abdomen (right). 2–*S. cruciger* Sabrosky & Steyskal; male (left) and female abdomen (right). 3–*S. flaviseta* (Johnson); female. 4–*S. latifacies* Sabrosky & Steyskal; male (left) and female abdomen (right). 5–*S. atrifacies* Sabrosky & Steyskal; female. 6–*S. affinis* (Johnson); male (left) and female abdomen (right). 7–*S. muesebecki* Sabrosky & Steyskal; male (left) and female abdomen (right). 8–*S. flava* Melander & Argo; male (left) and female (right; arista not illustrated). 9–*S. atricornis* Sabrosky & Steyskal; male (left) and female (right; head not illustrated).



FIGURES 10–17. 10–*Sobarocephala latifrons* (Loew); male (left) and female (right; head not illustrated). 11–*S. wirthi* spec. nov.; male (left) and female abdomen (right). 12–*S. pengellyi* spec. nov.; male (left) and female abdomen (right). 13–*S. interrupta* Sabrosky & Steyskal; male (left) and female abdomen (right). 14–*S. dreisbachi* Sabrosky & Steyskal; male (left) and female abdomen (right). 15–*S. setipes* Melander & Argo; male (left) and female (right; head not illustrated). 16–*S. lachnosternum* Melander & Argo; male (left) and female abdomen (right). 17–*S. texensis* Sabrosky & Steyskal; male.

Species Descriptions

***Sobarocephala affinis* (Johnson, 1913)** (Figs. 6, 39–41; Map 1)

Chaetoclusia affinis Johnson, 1913: 101. Melander & Argo, 1924: 9.
Sobarocephala testacea Soós, 1964: 449. Sabrosky & Steyskal, 1974: 378.
Sobarocephala affinis, Woodley, 1984: 120.

Redescription (Fig. 6)

Male. Body length 2.8-4.4 mm. Bristles yellow. Two dorsocentral bristles with one minute bristle in front of anterior dorsocentral. Acrostichal bristle absent. Two pairs of well-developed lateral scutellar bristles. Arista densely plumose. Sides of frons parallel. Body yellow except as follows: fore tibia usually light brown to brown; fore tarsi dark brown; coxae, base of femora, posterior half of katepisternum, parafacial and gena white; first flagellomere with dark spot around base of arista; occiput occasionally pilose. Male from Alabama with one pair of small spots behind suture, and lateral margin of postpronotum (and part of notopleuron) brown. M_{1+2} ratio 3.9-4.6. Wing clear. Cell bm open. Face flat.

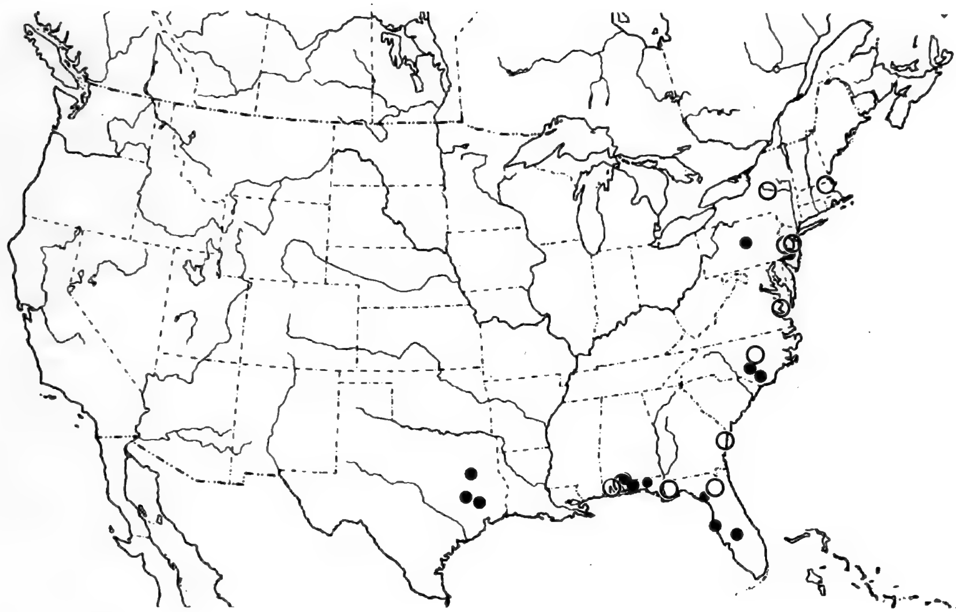
Female. Externally similar to male except as follows: abdomen with median stripe on tergites (2) 3-4; tergites 5-7 and anterior half of tergite 8 brown.

Male terminalia. (Figs. 39–41) Similar to *S. muesebecki*, except pregonite ovate and hypandrium with four minute distal bristles.

Distribution: United States: AL, FL, GA, MA, NC, NJ, NY, VA (Map 1).

Holotype. UNITED STATES, VA: Cape Henry, 26 June 1939, A. L. Melander, ♂, USNM.

Additional material examined. UNITED STATES, AL: Kushla, 22 July 1914, A. H. Sturtevant, ♂, USNM; **Baldwin Co.**, Bon Secour Nat. Wildlife Refuge, 5-7 May 1994, S. A. Marshall, ♂, DEBU; Bon Secour (site 4), Malaise, 19 October 2004, 30.30N, 88.74W, E. Benton, ♀, DEBU. **FL: Alachua Co.**, Gainesville, Austin Cary Forest, insect flight trap, CO_2 baited, G. B. Fairchild, 6 August 1976, 2♂, 2♀, USNM; 9 August 1976, ♂, ♀, USNM; 13 August 1976, ♀, USNM; 20 August 1976, ♂, ♀, USNM; 17 September 1976, ♀, USNM; 30 July 1976, ♂, USNM; 26 July 1976, ♀, USNM; 16 August 1976, ♀, USNM; Gainesville, Pine Hill Estates, H. V. Weems Jr., Malaise trap, 26 September 1973, ♀, USNM; 3 October 1973, ♀, USNM; Gainesville, Pierce's homestead, 8 April 1976, W. H. Pierce, flight intercept trap, ♀, USNM; **Mobile Co.**, Camp Scoutshire (site 24), Malaise trap, 14 December 2004, 31.05N, 88.18W, E. Benton, ♀, DEBU. **GA: Liberty Co.**, St. Catherine's Isl., 18-21 September 1972, F. C. & B. J. Thompson, ♂, AMNH; 24-28 April 1972, Thomas & Picchi, ♀, AMNH. **MA:** Concord, 19 July 1961, W. W. Wirth, marsh, ♂, USNM. **NC: Wake Co.**, 7 air mi. SW of Raleigh off rd., Malaise trap, C. S. Parron, 21 September 1985, ♂, NCSU; 14 August 1985, ♂, NCSU; 2 July 1985, ♀, NCSU; 30 August 1985, ♀, NCSU. **NY:** Kalfleisch, 15 August 1962, R. S. Huntington, ♀, USNM.



MAP 1. Distribution of *Sobarocephala affinis* (Johnson) (circle) and *S. muesebecki* Sabrosky & Steyskal (dot).

Comments. While the sister-species *Sobarocephala muesebecki* and *S. affinis* are both largely restricted to the eastern and southeastern coastal United States, the range of *S. muesebecki* extends further west into Texas and Pennsylvania. Males of *S. muesebecki* and *S. affinis* are easy to separate using the colour of the epandrium, but females are much more difficult to distinguish: the bristles of *S. muesebecki* are darker and the anterior margin of the frons is light yellow to white, but these characters are often difficult to see in poorly preserved specimens.

***Sobarocephala atricornis* Sabrosky & Steyskal, 1974** (Figs. 9, 30–32; Map 2)

Sobarocephala atricornis Sabrosky & Steyskal, 1974: 382.

Redescription (Fig. 9).

Male. Body length 3.0-3.3 mm. Bristles dark brown. Two dorsocentral bristles. Acrostichal bristle present. Two pairs of well-developed lateral scutellar bristles. Arista sparsely plumose. Sides of frons parallel. Notum yellow, usually with light to dark spot on and (usually) behind notopleuron (pigment sometimes indistinct). Pleuron and legs light yellow to white. Head largely yellow, with ocellar tubercle brown and ventral half of first

flagellomere black; parafacial and gena white and silvery tomentose. Abdomen yellow. M_{1+2} ratio 4.4. Wing clear or with cloud around apex of R_{2+3} (sometimes filling first radial cell). Cell bm open. Face flat.

Female. As described for male except as follows: bristles black; scutum yellow with lateral margin dark brown (sometimes faded) (one female from Ontario (DEBU) with scutum yellow excluding brownish lateral margin on notopleuron); scutellum sometimes with thin brown border along lateral margin; laterotergites brown, sometimes yellow below scutellum; face white; fore tarsi sometimes light brown; tergites 2-4 sometimes with small spot on posterior margin; tergite 6 and basal margin of tergite 7 brown; lateral stripe present along length of abdomen (not visible dorsally).

Male terminalia. (Figs. 30–32) Sternite 5 evenly setose. Sclerites of annulus well-developed. Width of epandrium 4/5 height and length 3/5 height. Surstylus 2/3 height of epandrium, slightly wider on distal half; tubercle-like bristles along length of posterior margin, but more concentrated apically. Cerci projecting and rounded; bristles short with several slightly longer central bristles. Ventral lobe of hypandrium long with three minute distal bristles; arm short and truncate. Phallapodeme well-developed. Pregonite ovate, membranous, and possibly fused to hypandrium. Postgonite and basiphallus small. Epiphallus long, projecting, and perpendicular to basiphallus. Distiphallus half length of phallapodeme, and lateral lobe thin, hooked, spinulose distally, and without thumb.

Distribution. Canada: ON, PQ. United States: KS, MA, MI, NY (Map 2).

Holotype. CANADA, ON: Maynooth, 8 July 1965, J. F. McAlpine, ♂, CNCI.

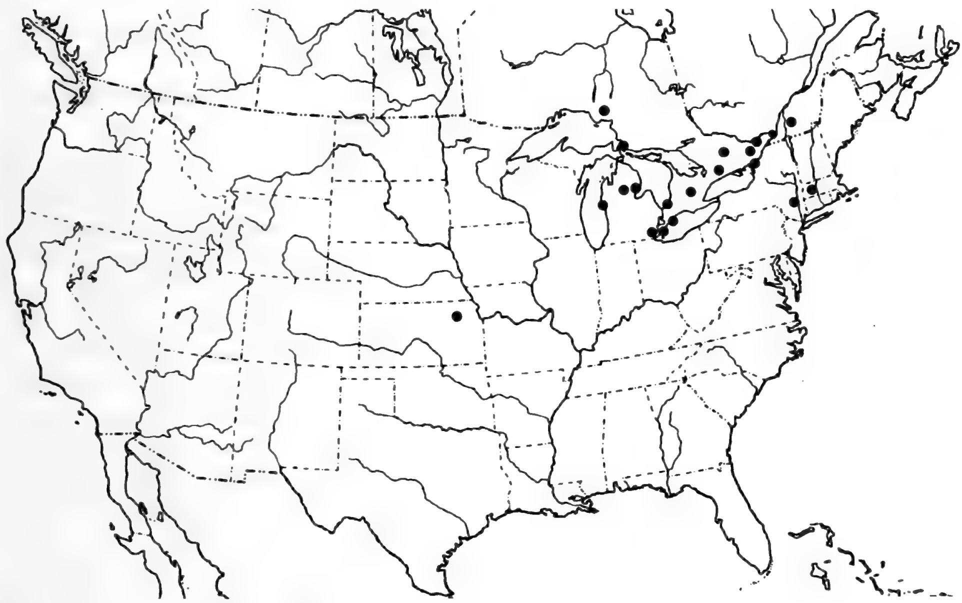
Allotype. UNITED STATES, MI: Claire Co., 23-28 July 1959, R. R. Dreisbach, ♀, USNM.

Paratypes examined. CANADA, ON: Ottawa, J. R. Vockeroth, 12 July 1959, ♀, CNCI; 9 July 1962, ♀, CNCI. **PQ:** Abbotsford, 23 June 1937, G. Shewell, ♀, CNCI. **UNITED STATES, MI: Monroe Co.**, J. Truchan, ex. Malaise trap, 1 August 1965, ♂, USNM; 1 July 1965, ♀, USNM.

Additional material examined. CANADA, ON: Innisville, 12 July 1963, W. R. M. Mason, ♀, CNCI; White R., July 1980, S. A. Marshall, ♀, DEBU; Five Points, 25-30 July 1983, Malaise trap, J. Thompson, ♀, DEBU; **Wellington Co.**, University of Guelph Arboretum, ex. dung, O. Lonsdale, 9 August 2004, ♀, DEBU [in alcohol]; 19 July 2005, ♂, DEBU [in alcohol]; University of Guelph Arboretum, B. Brown, unbaited pitfalls, 22 May–8 July 1983, ♀, DEBU; mushroom baited pitfalls, 19 July 1983, 2♀, DEBU; Guelph, 11 July 1981, J. Ernst, ♀, DEBU; Fergus, Malaise trap, S. A. Marshall, 16 July 1990, 2♀, DEBU; 9 July 1990, ♀, DEBU; 10 July 1990, ♀, DEBU; Rondeau, 25 July 1981, S. A. Marshall, dung trap, ♀, DEBU; **Lambton Co.**, Port Franks, Watson Property, pans, J. Skevington, 15-18 July 1996, 5♀, DEBU; 31 July–6 August 1996, ♀, DEBU; 27 June–2 July 1996, ♀, DEBU; 18-22 July 1996, ♀, DEBU; Sault Ste. Marie, Ft. Creek Cons. Area, 8 July 1998, K. N. Barber, sweeps, *Impatiens*, sedge, fern, 46°32.5'N, 84°20.8'W, ♂, DEBU; Sault Ste. Marie, Birchwood Park, 27 July 1986, K. N. Barber, mixed forest, ♀, DEBU; **Essex Co.**,

Point Pelee N. P., Visitor Centre, Malaise trap and pans, 6-11 August 2000, O. Lonsdale, ♀, DEBU; Ottawa, J. R. Vockeroth, damp, second-growth *Acer-Betula* wood, 16 July 1989, ♂, CNCI; 4 July 1991, ♀, CNCI; 7 mi E Griffith, 11 July 1990, B. E. Cooper, ♂, CNCI; McDonald Island, St. Lawrence Isl. N. P., A. Carter, 15 July 1976, ♀, CNCI; Ottawa, 13 August 1974, J. R. Vockeroth, ♀, CNCI. **UNITED STATES, KS: Riley Co.**, Manhattan, 8 July 1966, Malaise trap, G. F. Hevel, ♀, USNM. **NY:** Corlear Bay, L. Champlain, June 1939, R. C. Shannon, ♂, USNM; **Ulster Co.**, Cherrytown, 4 mi NNW Kerhonkson, 15-30 July 1971, P. & B. Wygodzinsky, ♀, AMNH.

Comments. *Sobarocephala atricornis* can be readily diagnosed by a ventrally black first flagellomere (hence its name). If the antennae are missing, females can be identified by their characteristic notal and abdominal patterns. Male *S. atricornis* are more difficult to identify because, like many other North American *Sobarocephala*, they are weakly pigmented and have dark bristles, however they can be distinguished by their clear wings and brown supra-alar spots.



MAP 2. Distribution of *Sobarocephala atricornis* Sabrosky & Steyskal.

Sobarocephala atrifacies **Sabrosky & Steyskal, 1974** (Fig. 5; Map 3)

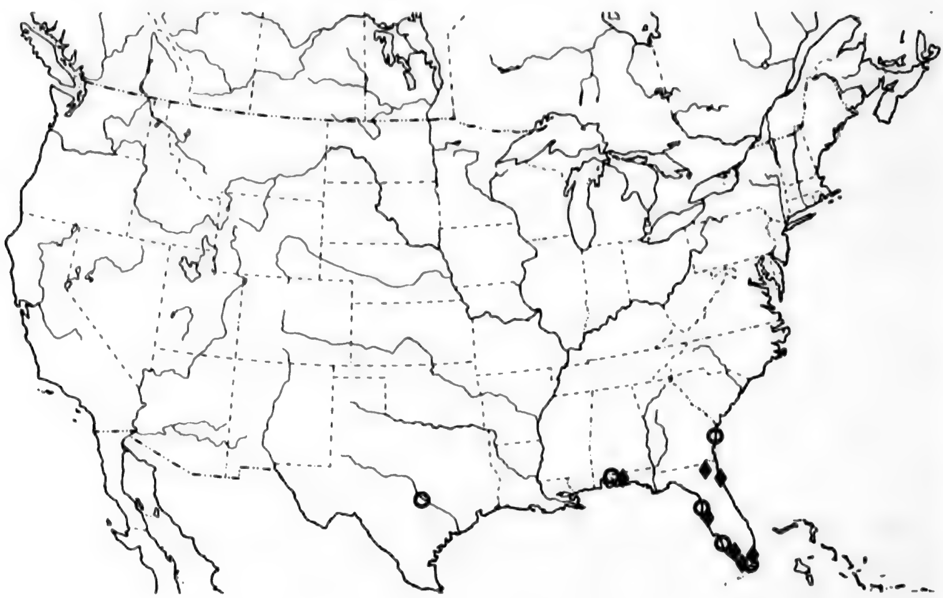
Sobarocephala atrifacies Sabrosky & Steyskal, 1974: 379.

Redescription (Fig. 5)

Female. Body length 3.8-4.4 mm. Bristles light brown. Two dorsocentral bristles. Acrostichal bristle present. Two pairs of well-developed lateral scutellar bristles. Arista pubescent. Sides of frons converging posteriorly. Thorax mostly yellow; notopleuron, postpronotum, scutellum, laterotergites beside scutellum and posterior notal spots white; one pair of dark brown supra-alar spots and one large posteromedial spot; if face yellow, anterior margin of scutum brown, including inner half of postpronotum. Coxae white. Legs mostly yellow, with tarsi dirty white to light brown, and fore tarsomeres 2-5 and distal 1/3 of tarsomere 1 brown. Head predominantly yellow, with parafacial and gena white, face black (yellow in some Dominican Republic specimens), and ocellar tubercle brown. Abdomen yellow with tergites 3-6 dark brown (tergites 5 and 3 yellow on anterior corner). Cerci brown. M_{1+2} ratio 3.7. Wing clear. Cell bm closed. Face flat.

Male. Unknown.

Distribution. Florida (Map 3), Dominican Republic.



MAP 3. North American distribution of *Sobarocephala atrifacies* Sabrosky & Steyskal (diamond) and *S. quadrimaculata* Soós (circle).

Holotype. UNITED STATES, FL: Pinellas Co., High Point, 17 November 1971, K. Hickman, ♀, USNM.

Paratypes. UNITED STATES, FL: Dade Co., Miami, 3 November 1971, G. R. Searis, McPhail trap in Loquat tree, 6♀, USNM.

Other material examined. DOMINICAN REPUBLIC. Pedernales, 26 km N Cabo Rojo, 18°06'N, 71°38'W, 730 m, 13-25 July 1990, L. Masner, J. Rawlins & C. Young, wet deciduous forest, intercept trap, 2♀, CMNH; RD-095 Rodeo, ~0.5 km E Presa de Blanco, Bonao, Monsenor Nouel Prov., 20 March 2003, D. Perez, R. Bastardo, B. Hierro, ♀, USNM.

Comments. The paratypes from Florida were collected on grapefruit and guava trees (Sabrosky and Steyskal 1974).

***Sobarocephala cruciger* Sabrosky & Steyskel, 1974** (Figs. 2, 24–26; Map 4)

Sobarocephala cruciger Sabrosky & Steyskal, 1974: 376.

Redescription (Fig. 2)

Male. Body length 3.5-5.4 mm. Bristles yellow. Two dorsocentral bristles. Acrostichal bristle absent. Two pairs of well-developed lateral scutellar bristles. Ocellar bristle absent. Arista densely plumose. Sides of frons converging posteriorly. Scutum mostly yellow; lateral margin with one pair of brown spots behind transverse suture and one pair of spots abutting scutellum; postpronotum light yellow. Scutellum brown laterally. Anatergite brown below scutellum. Pleuron and legs yellow with fore tarsi brown. Coxae white. Head mostly yellow, with gena and parafacial white, and first flagellomere brown on dorsal half; gena silvery tomentose. Tergites 1-5 with central brown stripe; posterior half of tergite 4 brown; tergite 6 with small central spot; surstylus white; remainder of abdomen yellow. M_{1+2} ratio 4.0-4.8. Wing clouded on distal 1/3. Cell bm open. Face convex on dorsal half below antennal bases.

Female. Externally as described for male except anatergite and tergite 6 with brown medial stripe, tergite 7 light brown, and cerci brown.

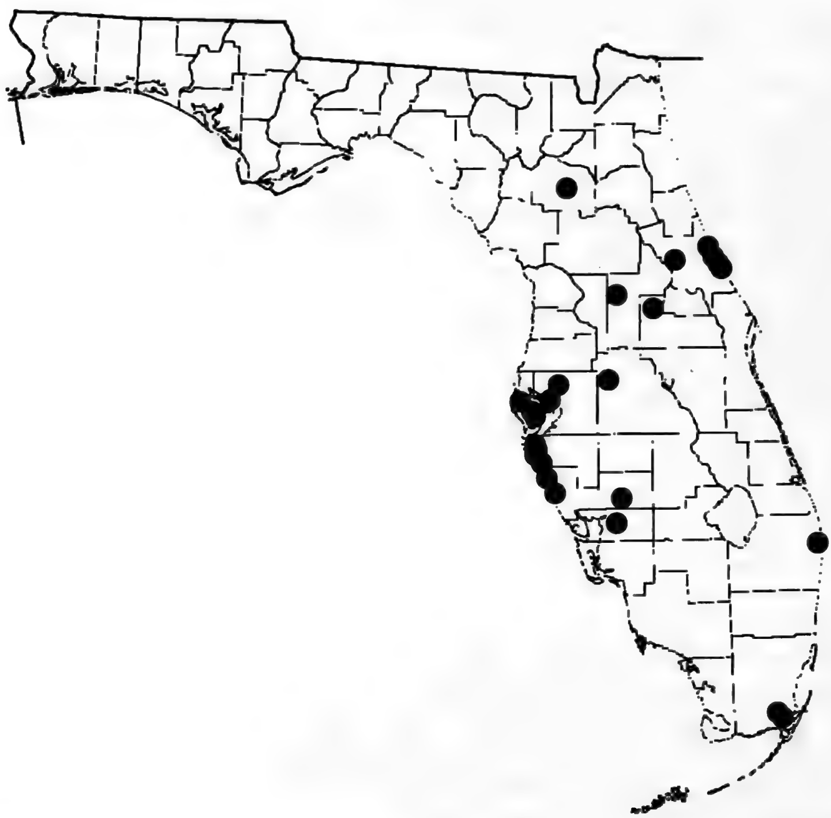
Male terminalia. (Figs. 24–26) Sternite 5 evenly setose. Annulus reduced to thin band ventrally. Width of epandrium 2/3 height and length half height. Surstylus short, acutely triangular, and curved inwards; tubercle-like bristles terminal only. Cerci projecting and bifid. Hypandrial arm longer and thicker than ventral lobe, projecting at 90° basally (arcuate medially); ventral lobe with one minute and two long distal bristles. Pregonite long and thin with one distal bristle. Postgonite and basiphallus small. Epiphallus thin and weakly sclerotized. Distiphallus short and bent medially; lateral lobe truncate and minutely toothed distally with thumb half length of lobe.

Distribution. Florida (Map 4).

Holotype. UNITED STATES, FL: Manatee Co., Cedar Hammock, 16 September 1966, D. C. Chancey, Steiner trap, ♂, USNM.

Allotype. UNITED STATES, FL: Dade Co., Miami Springs, 3 January 1972, G. R. Searls, ♀, USNM.

Paratypes examined. UNITED STATES, FL: Sarasota, McPhail trap, C. K. Hickman, 13 March 1972, 3♂, USNM; Bradenton, Steiner trap, D. C. Chancey, 10 September 1965, ♀, USNM; 29 July 1966, ♀, USNM; **Volusia Co.**, S. Dayton, McPhail trap, J. N. Pott, 18 October 1966, ♂, 2♀, USNM; 5 October 1965, ♀, USNM; 10 March 1972, ♀, USNM; 14 May 1965, ♂, USNM; grapefruit tree, 29 October 1971, ♀, USNM; 12 October 1972, ♀, USNM; 10 March 1972, ♀, USNM; Allendale, McPhail trap, 3 November 1966, ♀, USNM; **Volusia Co.**, Harbour Oakes, McPhail trap, J. N. Pott, 28 October 1966, ♀, USNM; 3 November 1966, ♀, USNM; **Dade Co.**, Miami Springs, G. R. Searls, 3 January 1972, 3♀,



MAP 4. Map of Florida showing distribution of *Sobarocephala cruciger* Sabrosky & Steyskal.

USNM; 22 October 1971, ♀, USNM; C. F. Dawling Jr., McPhail trap, 20 February 1968, ♀, USNM; **Pinellas Co.**, High Point, McPhail trap, grapefruit tree, K. Hickman, 17 November 1971, ♀, USNM; **Sarasota Co.**, Osprey, McPhail trap, S. V. Hiatt, 24 October 1966, ♀, USNM; **Hillsborough Co.**, Tampa, McPhail trap, T. J. Flavoroso, 1 August 1968, ♀, USNM; 9 October 1967, ♀, USNM; 20 October 1969, ♀, USNM; **Manatee Co.**, Palmetto, McPhail trap, 23 September 1966, C. J. Bickner, ♀, USNM; J. R. McFarlin, McPhail trap, 8 August 1971, 2♀, USNM; McFarlin & Bickner, 9 March 1972, 2♀, USNM.

Additional material examined. UNITED STATES, FL: Gainesville, Doyle Conner Bldg., Malaise trap, 23 September 1973, H. V. Weems Jr., ♀, USNM; **Alachua Co.**, Pierce's Homestead, Malaise trap, W. H. Pierce, 13 October 1973, ♀, USNM.

***Sobarocephala dreisbachi* Sabrosky & Steyskal, 1974** (Figs. 14, 54–56, Map 5)

Sobarocephala dreisbachi Sabrosky & Steyskal, 1974: 382.

Redescription (Fig. 14)

Male. Body length 3.3 mm. Bristles brown to dark brown. Two dorsocentral bristles with one minute bristle in front of anterior dorsocentral. Acrostichal bristle absent. Two pairs of well-developed lateral scutellar bristles. Arista sparsely plumose. Sides of frons parallel. Scutum yellow, with notopleuron brown to light brown and postsutural stripes brown (broadly connected at base). Scutellum and laterotergites beside scutellum brown (sometimes also with large spot below scutellum). Pleuron and legs light yellowish-white with fore tarsi brown and anepisternum sometimes yellow. Head yellow with orange tint (sometimes darker laterally), with ocellar tubercle brown and gena light yellow and pilose. Abdomen yellow. M_{1+2} ratio 4.8. Wing lightly clouded around distal half of R_{2+3}. Cell bm open. Face flat.

Female. Similar to male except tergites 3-6 and posterior margin of tergite 2 brown; posterior corners of tergite 5 yellow. Females from Québec with notopleuron yellow or light brown and fore tibia brown (tip lighter).

Male terminalia. (Figs. 54–56) Fifth sternite with posteromedial comb. Sclerites of annulus well-developed. Epandrium slightly wider than high; length approximately 3/5 width. Surstylus as high as epandrium, with outline subtriangular and broadly rounded; tubercle-like bristles absent. Cerci sunken below distal margin of epandrium, and all bristles short. Hypandrial arm atrophied; ventral lobe with one minute distal and two long medial bristles. Phallapodeme carinate and atrophied distally. Postgonite small. Pregonite membranous with one distal setula. Basiphallus well-developed. Epiphallus long, thin, and strongly projecting from basiphallus. Distiphallus 2/5 length of phallapodeme; thumb of lateral lobe short and truncate.

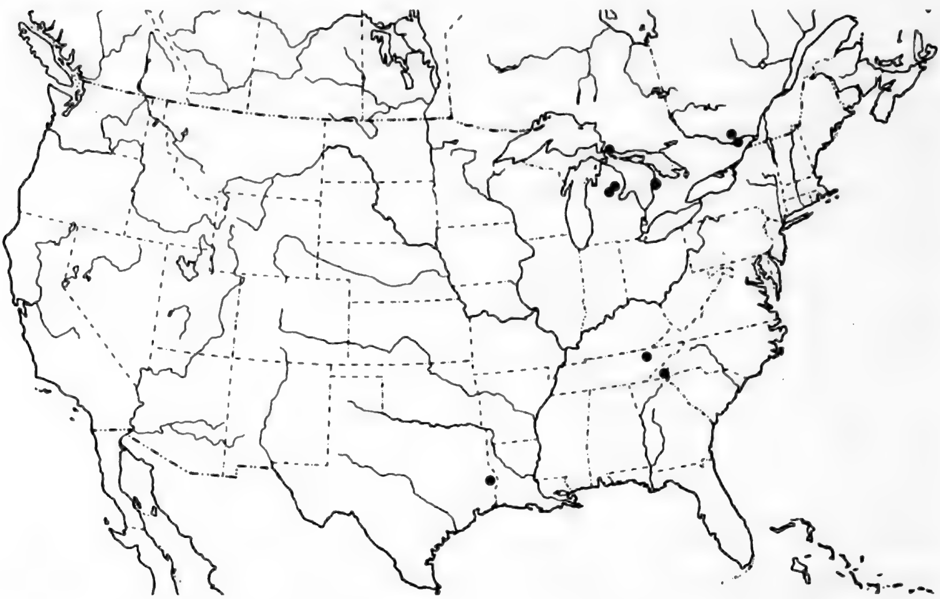
Distribution. Canada: ON, PQ. United States: MI, NC, TN, TX (Map 5).

Holotype. UNITED STATES, MI: Ogemaw Co., 1-2 August 1959, R. R. Dreisbach, ♀, USNM.

Paratypes. CANADA, ON: Ottawa, 26 July 1959, J. R. Vockeroth, ♂, CNCI. **UNITED STATES, NC: Macon Co.**, Wayah Gap, 3500 ft, 10 August 1957, J. G. Chillcott, ♂, CNCI.

Additional material examined. CANADA, ON: Algoma Dist., Hilton Twp., Hilton Beach, Malaise trap at edge of field and hardwood forest, 20 August 1992, J. E. Swann, ♀, DEBU; **Bruce Co.**, Inverhuron P. P., back dunes, 44°17'50"N, 81°35'27"W, 20 July–20 August 2003, Malaise, S. A. Marshall, ♀, DEBU. **PQ:** Duncan Lk., nr. Rupert, J. F. McAlpine, 6 August 1970, ♀, CNCI; 21 July 1971, ♀, CNCI; 16 July 1971, ♀, CNCI; 27 July 1971, ♀, CNCI. **UNITED STATES, TN: Union Co.**, 9 mi SE La Folette, 9 June 1973, A. O. Lavallee, ♀, EMUS. **TX: Jasper Co.**, Bouton Lake Rec. Area, Angelina Nat'l Forest 11 miles SE of Zavaila, off Texas Hwy 63, 15 May 1993, I. Yarom, ♂, TAUI.

Comments. The genitalia of *Sobarocephala dreisbachi* are similar to those of *S. setipes* and *S. lachnosternum*, in that there is a comb of bristles on the fifth sternite and the cerci are sunken, but the surstylus is much longer.



MAP 5. Distribution of *Sobarocephala dreisbachi* Sabrosky & Steyskal.

Sobarocephala flava **Melander & Argo, 1924** (Figs. 8, 33–35, Map 6)

Sobarocephala flava Melander & Argo, 1924: 40. Sabrosky & Steyskal, 1974: 383.
Sobarocephala populi Steyskal, 1951: 129.

Redescription (Fig. 8)

Male. Body length 2.8-5.3 mm. Bristles dark brown to black. Two dorsocentral bristles plus one minute bristle in front of anterior dorsocentral. Acrostichal bristle present. Lateral scutellar bristles weak to well-developed. Arista sparsely plumose. Sides of frons parallel. Notum yellow with notopleuron light brown to brown and lateral margin of scutum behind notopleuron sometimes brown. Pleuron, coxae, tibiae, and basal 1/3 of femora white, with fore tarsi light brown or yellow and anepisternum sometimes light yellow. Head yellow with ocellar tubercle brown and sclerites below antenna white; gena pilose. Abdomen yellow. M_{1+2} ratio 4.0. Wing dusky along R_{2+3} and costa (more so on distal ¼); occasionally clear. Cell bm open. Face flat.

Female. Similar to male except as follows: notopleuron rarely yellow (yellow in holotype); face, parafacial, and gena sometimes light yellow to white; first flagellomere with light infuscation along anterior margin; tergites 6-7 brown (tergite 7 usually only pigmented anterolaterally); specimens from Mississippi with tergites 2-5 (sometimes also tergites 7 and 8) brown laterally; female from Texas mostly yellow, with notopleuron light brown, and tergites 6 and 7 dark brown anteriorly and laterally. Female from Rondeau Provincial Park (Ontario) with entire lateral margin of scutum and scutellum dark brown.

Male terminalia. (Figs. 33–35) Externally similar to *S. atricornis* (Figs. 30, 31) except apex of surstylus slightly broader. Internally similar to *S. atricornis* (Fig. 32) except as follows: pregonite clavate with five bristles along length; only two hypandrial bristles usually present; lateral lobe strongly bent medially with thumb short, pointed, and projecting at 90°.

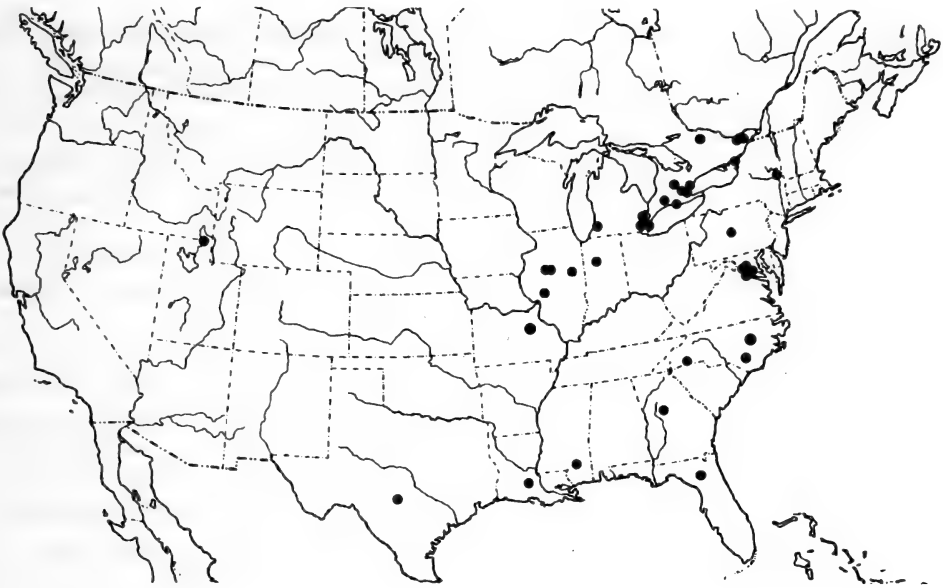
Distribution. Canada: ON. United States: FL, GA, IL, IN, LA, MD, MI, MO, MS, NC, NY, PA, TX, UT, VA (Map 6).

Holotype. UNITED STATES, VA: Fairfax Co., Dead Run, ISS 15 April [year unknown], ♀, USNM.

Paratypes examined. UNITED STATES, LA: Opelousas, April 1917, ♀, USNM. **MI:** Plummer Isl., 29 June 1913, ♀, USNM. **VA:** Dead Run, R. C. Shannon, 15 July 1915, 3♀, USNM; ex. Maple log, 13 March 1915, ISS 19 April 1915, ♀, USNM; 11 July 1915, ♀, USNM; Falls Church, N. Banks, June 1920, ♀, USNM; 4 July 1913, F. Knab, ♀, USNM.

Additional material examined. CANADA, ON: 7 mi E Griffith, 1 July 1990, B. E. Cooper, 2♀, CNCI; Hamilton, 13-19 July 1980, Malaise trap, M. Sandborne, 2♀, DEBU; Burlington, Royal Bot. Gardens, 16 July 1997, K. N. Barber, sweeps, trail-side *Poa, Agrostis, Phleum, Festuca, Juncus*, 43°17.5'N, 79°52.4'W, ♀, DEBU; Burlington, Bronte Crk. Prov. Pk., 17-20 August 1983, Brown & Marshall, Malaise trap, ♀, DEBU; Dundas, May 1980, E. A. Menard, reared, larva in dead Elm, ♀, DEBU; Algonquin Prov. Pk., Swan Lk. Res. Sta.,

reared from rothole in dead Maple tree, emerged 30 May 1995, D. C. Caloren, ♀, DEBU; Five Points, 29-30 July 1983, J. G. Thompson, ♀, DEBU; Fergus (yard), 9 August 1985, S. A. Marshall, floodplain, Malaise trap, ♀, DEBU; Fergus, Malaise trap, S. A. Marshall 8-14 June 1982, ♀, DEBU; 16 July 1990, ♀, DEBU; Port Credit, 15 July 1918, M. C. Van Duzee, ♀, CASC; Bells Corners, E. C. Becker, 31 May 1954, reared from under Beech, ♀, USNM; 21 June 1954, reared ex. puparia on rotten log, ♂, USNM; Bells Corners, reared ex. puparia on rotten log, 21 June 1954, E. C. Becker, 5♂, 6♀, CNCI; Ottawa, J. R. Vockeroth, damp second-growth *Acer-Betula* wood, 4 July 1991, 3♀, CNCI; 2 July 1992, 2♀, CNCI; 11 July 1989, ♀, CNCI; 13 August 1991, 2♀, CNCI; 6 July 1991, ♀, CNCI; 28 July 1991, ♀, CNCI; 9 August 1992, ♀, CNCI; McDonald Isl., St. Lawrence Isl. N. P., A. Carter, Malaise trap, 19 July 1976, ♀, CNCI; 20 July 1976, ♀, CNCI; 5 August 1976, ♀, CNCI; Metcalfe, B. E. Cooper, 24 July 1984, 2♀, CNCI; 22 July 1984, ♀, CNCI; 4 August 1984, ♀, CNCI; 1 August 1984, ♀, CNCI; **Essex Co.**, Point Pelee, 18 July 1978, J. M. Cumming, ♀, DEBU; Windsor, Ojibway Prairie, S. Paiero unburnt forest, yellow pans, 3-6 July 2001, ♀, DEBU; 31 July–3 August 2001, ♀, DEBU; burnt savannah, yellow pans, 25-29 June 2001, ♀, DEBU; **Kent Co.**, Rondeau P. P., Spicebush Trail, 42°18'09"N, 81°51'06"W, Carolinian forest, Malaise, 16-29 July 2003, S. A. Marshall, 2♀, DEBU. **UNITED STATES, FL:** Gainesville, Pine Hill Estates, 4 October 1973, H. V. Weems Jr., Malaise trap, ♀, USNM. **GA:** Forsyth, 2 June 1970, 2♀, CNCI. **IL: Champaign Co.**, Brownfield Woods, 2 mi NE Urbana, 29 June 1976, C. T. Maier, ♀, EMUS; **Mason Co.**, Sandridge St. Forest, 4 mi NW Forrest City, 23 June 1976, C. T. Maier, ♀, EMUS; **Tazewell Co.**, 3 mi N Macking along Panther Cr., Webb & Marlin, 10 June 1969, ♂, EMUS; Carlinville, 9 May 1952, M. R. Wheeler, ♂, AMNH. **IN:** La Fayette, 8 July 1916, ♂, USNM; July 1912, ♂, USNM; J. M. Aldrich, 3 July 1915, ♀, USNM; August 1914, ♂, USNM; July 1921, ♂, USNM. **MD:** Plummers Isl., 11 July 1915, R. C. Shannon, ♀, USNM; Colesville, W. W. Wirth, 11 July 1974, 4♀, USNM; 4 July 1976, ♀, USNM; 18 June 1977, 2♀, USNM; 14 June 1977, ♀, USNM; 28 July 1976, ♀, USNM; **Montg'y Co.**, Colesville, W. W. Wirth, Malaise trap, 30 June 1977, ♂, USNM; 26 June 1977, ♂, 2♀, USNM; Montg'y Co., Dickerson, G. A. Foster, 14 July 1974, 2♂, USNM; Montg'y Co., Rockville, W. W. Wirth, Malaise trap, 4 September 1977, ♀, USNM; 3 August 1979, ♂, USNM; 26 July 1979, ♀, USNM; Montg'y Co., Chevy Chase "woodend", 3 August 1974, G. F. Hevel, ♀, USNM; **Prince Georges Co.**, Patuxent Wildlife Res. Centre, W. W. Wirth, 8 July 1978, ♀, USNM; J. F. Reinert 31 July 1977, ♀, USNM; Glen Echo, J. R. Malloch, 23 July 1921, ♀, USNM; Laurel, 11 June 1965, marsh edge, 3♀, CNCI; Prince George Co., Beltsville, 15 July 1979, A. Freidberg, ♀, TAUI. **MI:** Grosse Ile, 30 June 1949, G. Steyskal, ♀, USNM; **Berrien Co.**, St. Joseph, D. D. Wilder, 14 July 1971, ♀, USNM; **Monroe Co.**, 20 July 1965, J. Truchan, ex. Malaise trap, ♂, USNM; **Wayne Co.**, Grosse Isle, G. C. Steyskal, 1 July 1949, ♀, USNM; 14 June 1949, ♀, USNM; 4 June 1962, ♀, USNM; 4 August 1956, 2♀, USNM; 3 August 1951, 2♀, USNM; 7 August 1951, ♀, USNM; 8 August 1956, ♀, USNM; 22 June 1949, ♀, USNM; 24 July 1951, 6♀, USNM. **MO:** Columbia, Malaise trap, 24 June 1967, 4pm–7am, F. D. Parker, ♀, USNM. **MS: Forrest Co.**, 6 mi W Wiggins, Sweet Bay Bog, dung trap, 5-8 May 1994, sphagnum, S. A. Marshall, 3♀, DEBU. **NC: Columbus Co.**, Lk. Waccamaw, 6 July 1985, W. Stein & A. Gerberich, blacklight in Oak & Pine scrub sand barriers nr lake, ♀, USNM; **Bladen Co.**, Singletary Lk. St. Pk., 34°35'0N, 78°27'30W, Malaise, 19-22 May 2003, Marshall & Paiero, ♀, DEBU; **Wake Co.**, 7 air mi SW of Raleigh off rd., 1 September 1985, C. S.



MAP 6. Distribution of *Sobarocephala flava* Melander & Argo.

Parron, Malaise trap, ♀, NCSU; Raleigh, late July, F. Sherman, ♀, NCSU. **NY:** Brainard, **Rensselaer Co.**, 11-22 July 1966, P. & B. Wygosinsky, ♀, AMNH. **PA:** State College, **Centre Co.**, 4 July 1972, D. J. Shetlar, ♀, CASC. **TX:** Kerrville, 23 April 1959, Becker & Howden, ♀, CNCI. **UT:** Garden City, 15 July 1951, F. C. Harmaton, ♀, USNM. **VA:** Alexandria, 24 June 1951, W. W. Wirth, ♂, USNM; St. Falls, 9 July 1926, A. L. Melander, ♀, USNM; Falls Church, Holmes Run, 6 August 1960, light trap, ♂, USNM; Dead Run, 28 July 1915, ♀, USNM; 29 June 1915, ♀, USNM; R. C. Shannon, 15 July 1915, ♀, USNM; 28 July 1915, ♀, USNM; Scott Run, July 1954, M. R. Wheeler ♂, ♀, USNM; Marina National Airport, 28 August 1994, A. Freidberg, ♀, TAUI.

Comments. *Sobarocephala flava* is a commonly collected species throughout much of eastern North America; specimens have also been collected in central Texas and Utah.

***Sobarocephala flaviseta* (Johnson, 1913)** (Figs. 3, 18–20; Map 7)

Heteromeringia flaviseta Johnson, 1913: 99.
Heteromeringia convergens Malloch, 1922: 50.
Sobarocephala flaviseta, Sabrosky & Steyskal 1974: 380.

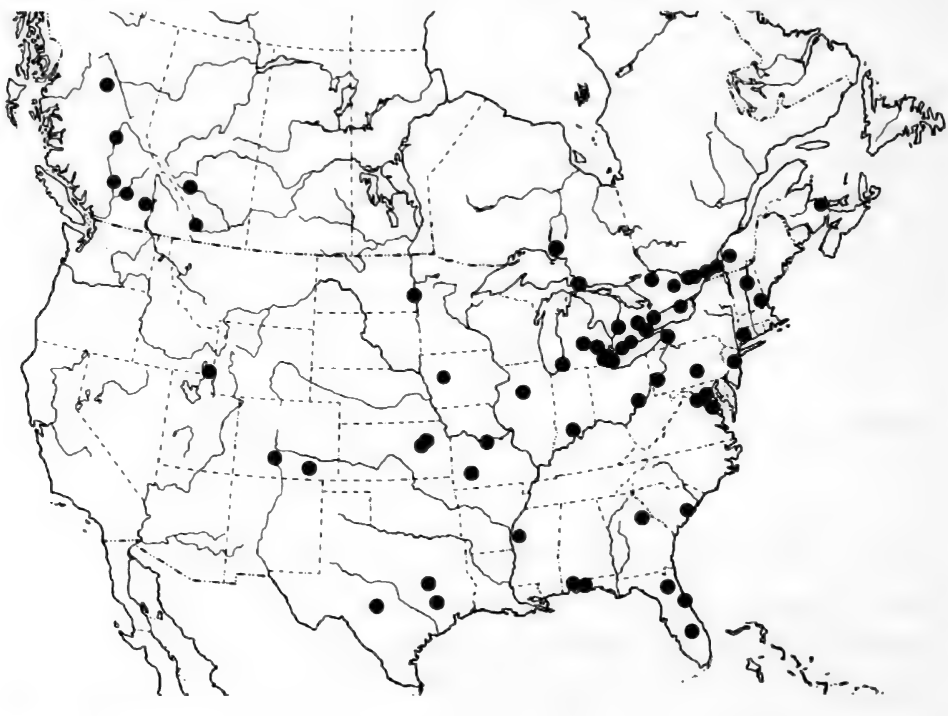
Redescription (Fig. 3)

Male. Body length 3.0-5.0 mm. Bristles brown. Two dorsocentral bristles plus one minute bristle in front of anterior dorsocentral. Acrostichal bristle present. Two pairs of

well-developed lateral scutellar bristles. Arista sparsely plumose. Sides of frons converging posteriorly. Scutum yellow with postpronotum and notopleuron white (at least centrally). Pleuron light yellow. Legs light yellow with coxae and base of femora white. Head yellow to white, with ocellar tubercle brown, and with parafacial, gena, sides of face, and scape white. Abdomen yellow. M_{1+2} ratio 3.1-3.3. Wing clear (sometimes clouded distally in first radial cell). Cell bm closed. Face, parafacial, and anterior margin of frons uniformly bulging.

Female. As described for male except as follows: tergite 3 with faded central stripe; tergites 4 and 5 light brown with anterior-lateral corners widely yellow; abdominal pattern sometimes reduced to central stripe on tergite 5. Cercus light brown.

Male terminalia (Figs. 18–20). Sternite 5 evenly setose. Sclerites of annulus well-developed. Epandrium as wide as high and length 3/4 height. Surstylus short, acute, and curved inwards; tubercle-like bristles distal only. Cerci projecting and slightly emarginate with one pair of slightly longer central bristles. Hypandrial arm stout and projecting at 90°; ventral lobe thin, slightly longer than arm, and with one minute and two long distal bristles. Phallapodeme well-developed and slightly sinuate. Pregonite narrow basally, wide distally and with five apical bristles. Postgonite absent. Distiphallus ¾ length of phallapodeme and curved at base; lateral lobe wide, truncate, minutely serrate, and with long thumb.



MAP 7. Distribution of *Sobarocephala flaviseta* (Johnson).

Distribution. NB, ON, PQ and eastern U.S. to BC, AB, ID, CO, and TX (Map 7).

Holotype. UNITED STATES, NJ: New Brunswick, 28 May, J. B. Smith, ♀, MCZC.

Paratypes examined. UNITED STATES, IN: Lafayette, July 1927, ♀, USNM. **VA:** Chainbridge, 20 August 22, J. R. Malloch, ♀, USNM. **NJ:** same collection as holotype, ♀, MCZC.

Additional material examined. 19♂, 198♀ [AMNH, CNCI, DEBU, TAMU, TAUI, USNM].

Comments. *Sobarocephala latifrons* and *S. flaviseta* are two of the most commonly encountered *Sobarocephala* in northeastern North America, although neither is as frequently collected as species of *Clusia* or *Clusiodes*. *Sobarocephala flaviseta* is common in eastern North America, and it has been occasionally collected in Texas and the northwest (Sabrosky and Steyskal 1974).

The apparent female-biased sex ratio of over 10:1 is unusual, although females of other species are generally more often collected than males. We suspect that this apparent female-biased sex ratio is a collecting artifact, and is more likely to reflect the clumping of males at mating sites than a population-level ratio. Too few reared specimens are available to assess actual sex ratios of any clusiid species.

***Sobarocephala interrupta* Sabrosky & Steyskal, 1974** (Figs. 13, 51–53; Map 8)

Sobarocephala interrupta Sabrosky & Steyskal, 1974: 384.

Redescription (Fig. 13)

Male. Body length 4.5 mm. Bristles light brown. Two dorsocentral bristles. Acrostichal bristle present. Arista sparsely plumose. Anterior lateral scutellar bristle minute or absent. Sides of frons parallel. Notum yellow, with notopleuron brown, scutum with one pair of basal spots (often serrate), and lateral margin of scutellum brown. Pleuron and legs light yellow with fore tarsi brown; Mississippi specimens with pleuron and basal half of femora white. Head yellow, with gena and parafacial dirty white to white, ventral margin of face sometimes orange, and ocellar tubercle brown; gena pilose. Abdomen yellow with tergites 2-5 brown (excluding anterior corners). M_{1+2} ratio 3.6-5.5. Wing clear. Cell bm open.

Female. Similar to male except tergites 3 and 4 brown and tergite 6 with posterior margin light brown centrally. Scutellum entirely yellow in South Carolina paratype.

Male terminalia. (Figs. 51–53) Sternite 5 evenly setose. Sclerites of annulus well-developed. Epandrium as high as wide and length half height. Surstylus bifid with anterior lobe well bristled and posterior lobe sparsely setose with small conical tubercle-like bristles; lobes subequal in length. Cerci concave medially, flush with distal margin of epandrium, and with all bristles short. Hypandrial arm very short; ventral lobe with one minute distal and two long medial bristles. Phallapodeme thinned medially, wide and

truncate distally, and not extending past dorsal margin of hypandrium. Pregonite large and circular with four medial bristles. Postgonite thin and flat with four bristles. Basiphallus well-developed. Epiphallus small and well-sclerotized. Distiphallus nearly half length of phallapodeme; lateral lobe small and finger-like with thumb absent.

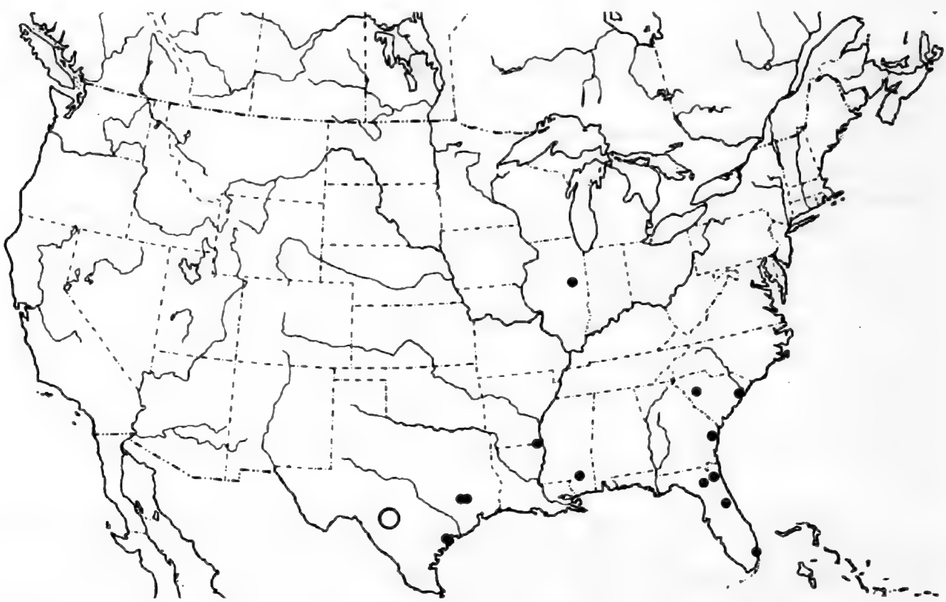
Distribution. United States: FL, GA, IL, LA, MS, SC, TX (Map 8).

Holotype. UNITED STATES, FL: Orange Co., Rock Springs, 21 April 1970, W. W. Wirth, ♂, USNM.

Allotype. UNITED STATES, FL: Alachua Co., Chantilly Acres, 25 April 1970, W. W. Wirth, Malaise trap, ♀, USNM.

Paratypes examined. UNITED STATES, LA: Kilbourne, 3 May 1959, W. W. Wirth, ♀, USNM. **SC:** Greenwood, Long Cane Lake, 21 July 1957, W. R. Richards, ♀, CNCI.

Additional material examined. UNITED STATES, FL: Gainesville, Doyle Conner Bldg., H. V. Weems Jr., Malaise trap, 16 October 1973, ♀, USNM; 8-9 September 1973, ♀, USNM; Highlands Hammock St. Pk., H. V. Weems Jr., 15 July 1956, ♀, USNM. **GA:**



MAP 8. Distribution of *Sobarocephala interrupta* Sabrosky & Steyskal (dot) and *S. texensis* Sabrosky & Steyskal (circle).

Liberty Co., St. Catherine's Isl., 18-21 September 1972, F. C. & B. J. Thompson, ♂, AMNH. **IL: Champaign Co.**, Brownfield Woods, 2 mi NE Urbana, 29 June 1976, C. T. Maier, ♀, EMUS. **MS: Forrest Co.**, 6 mi W Wiggins, Sweet Bay Bog, 5-8 May 1994, sphagnum, dung trap, S. A. Marshall, ♂ 3♀, DEBU. **SC: Georgetown Co.**, Hobcaw Barony, Belle Baruch Marine Field Lab, on slime mold, May 2004, S. A. Marshall, ♀, DEBU [in alcohol]. **TX: Montg. Co.**, Jones St. Forest, 8 mi S Conroe, 28 June–13 July 1987, Wharton, Steck, Carroll, ♂, TAMU; 1-7 June 1987, Wang, Wharton, Praetorius, Malaise trap, ♀, TAMU.

Comments. The medially yellow scutellum, characteristic notal stripes, and bifid surstylus most readily diagnose *Sobarocephala interrupta.*

Sobarocephala lachnosternum **Melander & Argo, 1924** (Figs. 16, 62–64; Map 9)

Sobarocephala lachnosternum Melander & Argo, 1924: 42. Sabrosky & Steyskal, 1974: 382.

Redescription (Fig. 16)

Male. Body length 3.9-4.9 mm. Bristles dark brown. Two dorsocentral bristles plus one minute bristle in front of anterior dorsocentral. Acrostichal bristle present. Two pairs of well-developed lateral scutellar bristles. Arista sparsely plumose. Sides of frons parallel. Scutum yellow with notopleuron dark brown (notopleuron sometimes faded, often in newly emerged adults). Scutellum and laterotergites yellow, although anatergite sometimes with one pair of light brown stripes lateral to scutellum. Pleuron light yellow to white excluding yellow anepisternum and katepisternum. Coxae white. Legs yellow with fore tarsi brown. Head yellow with parafacial and occiput white, gena white and silvery tomentose, ocellar tubercle brown, and anterior margin of frons with dirty yellow tint continuing onto dorsal margin of face. Abdomen light yellow, occasionally with light brown to brown bands on posterior margin of tergites 3-5 (faded medially). M_{1+2} ratio 3.1-3.5. Wing clear. Cell bm open. Face flat.

Female. Similar to male except as follows: posterior margin of tergite 2 sometimes brown; tergites 3 and 4 brown with anterior corners yellow; tergite 5 brown centrally and on posterior margin (sometimes reduced to light posterior spot); tergite 6 dark brown; remainder of abdomen yellow; pedicel brown in one female (Maryland).

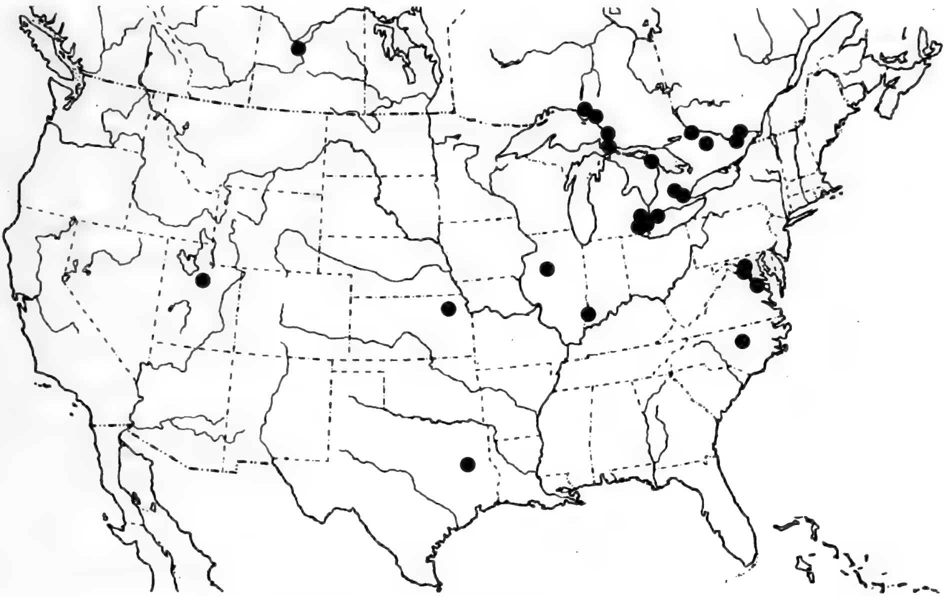
Male terminalia. (Figs. 62–64) Sternite five with comb of bristles on posteromedial margin. Sclerites of annulus well-developed. Epandrium large and barrel-shaped (as wide and high as pre-genitalic abdominal segments). Surstylus small and broadly rounded; tubercle-like bristles absent. Cerci small, rounded, slightly projecting, and with all bristles short. Ventral lobe of hypandrium elongate and poorly-defined with three minute bristles. Phallapodeme elongate and well-developed. Basiphallus well-developed. Epiphallus small. Postgonite large and ovate with several minute setulae. Pregonite absent. Distiphallus very short and curved; lateral lobe ovate.

Distribution. Canada: ON, PQ, SK. United States: IL, IN, KS, MD, MI, NC, TX, UT, VA (Map 9).

Holotype. UNITED STATES, VA: Rosslyn, R. C. Shannon, found larva 25 November 1912, ♂, USNM.

Paratypes. UNITED STATES, VA: Rosslyn, R. C. Shannon, found larva 25 November 1912, ISS 10 January 1913, ♂, USNM; bred specimen coll. 25 November 1912, ISS 26 January 1913, ♀, USNM; bred specimen coll. 25 November 1912, ISS 24 January 1913, ♂, USNM; ex. rotten log, 2 May 1913, ISS 20 May 1913, ♀, USNM; ex. rotten log, 2 May 1913, ISS 17 May 1913, ♂, USNM.

Additional material examined. CANADA, ON: Fergus, 10 July 1990, Malaise trap, S. A. Marshall, ♀, DEBU; Guelph, 21 July 1978, W. Ralley, ♀, DEBU; Dundas, 29 June 1981, J. Kircher, ♀, DEBU; Algonquin Prov. Pk., Swan Lk. Survey, 45°29'15"N, 78°43'20"W, Malaise trap, hemlock/hardwood, 16-28 July 1993, Larson, Marshall & Barr, ♀, DEBU; Shakwa Lk., Oulette Twp., 21 July 1996, A. Applejohn, ♀, DEBU; Hamilton, 19-28 August 1980, M. Sandborne, Malaise trap, ♀, DEBU; **Elgin Co.**, Springwater Cons. Area, 24 June 1996, D. C. Caloren, ♀, DEBU; **Bruce Co.**, Dunk's Bay, Malaise trap, S. A. Marshall, 17 July–18 August 1996, ♀, DEBU; Icewater Crk., 12.7 km NNE Searchmont, mi10.5 Whitmore Dam Rd., 24 June 1986, K. N. Barber, mixed forest, ♂, DEBU; [Nippising] Hwy#17, 7 km W Mattawa, 12 June–2 July 2004, opaque mini sticky traps, mixed forest, 46°17.3'N, 78°49.0'W, K. N. Barber, ♀, DEBU; Windsor, Malaise trap, S. A. Marshall, 7-16 August 1982, ♀, DEBU; Sault Ste. Marie, Bristol Pl. Pk., 2 July 2001, K. N. Barber, sweeps, mostly sedges, 46°30.8'N, 84°16.6'W, ♀, DEBU; 40 km SSW White River, K. N. Barber, boreal mixedwood, Malaise trap, 48°14.08'N, 85°22.02'W, 7-22 July 2003, ♀, DEBU; multi-colour sticky trap, 48°14.05'N, 85°21.97'W, 10-23 July 2003, ♂, 3♀, DEBU; 16-26 June 2003, ♂, DEBU; 48°14.14'N, 85°22.02'W, 26 June–10 July 2003, 7♂, 6♀, DEBU; Ottawa, 24 July 1972, J. R. Vockeroth, damp secondary growth *Acer-Betula* wood, ♀, CNCI; Innisville, 12 July 1963, W. R. M. Mason, ♀, CNCI; 7 mi E Griffith, 5 July 1990, B. E. Cooper , ♀, CNCI. **PQ:** Gatineau, King Mtn., S. A. Marshall, 23 August 1977, ♂, DEBU; Kirk's Ferry, 23 August 1924, G. S. Walley, ♂, CNCI; Duncan Lk. Nr. Rupert, J. F. McAlpine, 20 July 1969, ♀, CNCI; 28 July 1971, ♀, CNCI; 24 July 1971, ♀, CNCI. **SK:** Beaver Crk. Cons. Area, ~13 km S Saskatoon, 12 July 1999, K. N. Barber, sweeps, mostly grasses under *Betula/Populus*, 51°58.6'N, 106°43'W, 3♀, DEBU. **UNITED STATES, IL: Tazewell Co.**, 3 mi N Mackinaw along Panther Crk., Webb & Marlin, 10 June 1969, 2♂, EMUS. **IN: Posey Co.,** Harmonie St. Pk., 24-26 June 1998, Wharton et al., ♀, DEBU. **KS: Pottawatomie Co.**, 12 mi W Wamego, 24 July 1966, G. F. Hevel, ♀, USNM. **MD: Montg'y Co.**, Colesville, W. W. Wirth, Malaise trap, 26 June 1977, ♀, USNM; 15 August 1975, ♀, USNM; Colesville, W. W. Wirth, 6 August 1976, ♀, USNM; 28 July 1976, 2♀, USNM; Malaise trap, 13 August 1977, ♀, USNM; Montg'y Co., Bethesda, G. C. Steyskal, 9 August 1972, 2♀, USNM; Laurel, 11 June 1965, marsh edge, ♂, CNCI. **ME:** Dryden, 7 July 1959, G. H. Heinrich, ♀, CNCI. **MI: Wayne Co.**, Grosse Isle, G. C. Steyskal, 8 August 1956, ♀, USNM; 15 June 1949, ♀, USNM; 4 August 1956, ♀, USNM; 23 June 1956, ♂, USNM; 19 June 1955, ♂, USNM; **Monroe Co.**, 26 July 1956, J. Truchan, ex. Malaise trap, ♂, USNM. **NC: Wake Co.**, 7 air mi SW of Raleigh off rd., 25 July 1985, C. S. Parron, Malaise trap, ♀, NCSU. **TX:** Salmon, **Anderson Co.**, 6-19 October 1974, H. R. Burke, ♀, TAMU. **UT: Utah Co.**, Provo, Malaise trap, 6-9 July 1985, ♂, ♀, EMUS; 16-23



MAP 9. Distribution of *Sobarocephala lachnosternum* Melander & Argo.

July 1985, 2♀, EMUS; 20-27 July 1985, ♀, EMUS; 7-14 August 1985, 3♀, EMUS; 14-21 August 1985, ♀, EMUS; 6-16 July 1985, 3♀, EMUS; 18-26 June 1985, ♂, 14♀, EMUS; 25 June–6 July 1985, 11♀, EMUS. **VA:** Warsaw, 26 July 1952, W. W. Wirth, ♀, USNM.

Comments. While male *Sobarocephala lachnosternum* superficially resemble other pale North American *Sobarocephala*, they can be readily identified by a large barrel-shaped epandrium and small surstyli. Females can be identified by their characteristic abdominal pattern.

See comments for *Sobarocephala setipes*.

***Sobarocephala latifacies* Sabrosky & Steyskal, 1974** (Figs. 4, 21–23; Map 10)

Sobarocephala latifacies Sabrosky & Steyskal, 1974: 380.

Redescription (Fig. 4)

Male. Body length 3.0-5.6 mm. Bristles black. Two dorsocentral bristles plus one minute bristle in front of anterior dorsocentral. Acrostichal bristle present. Two pairs of well-developed lateral scutellar bristles. Arista short-plumose. Sides of frons converging posteriorly. Notum predominantly yellow with notopleuron brown to dark brown; scutum sometimes brown on lateral margin and laterotergites yellow or brown. Pleuron light yellow. Coxae white. Legs yellow with fore tarsi light brown (at least apically). Head yellow with gena and parafacial white, face light yellow and ocellar tubercle brown. Abdomen yellow.

M_{1+2} ratio approximately 3.0. Wing clouded in cell R_1, around distal 1/5 of R_{4+5}, and around R_{2+3}. Cell bm open. Face, parafacial, and anterior margin of frons uniformly bulging.

Female. Scutum as described for male. Abdomen yellow with tergites 6 and 7 brown and tergites 2-5 with small spot on anteromedial margin (tergites 2-5 sometimes with light brown medial stripe and light brown border, or only with posterior margins brown).

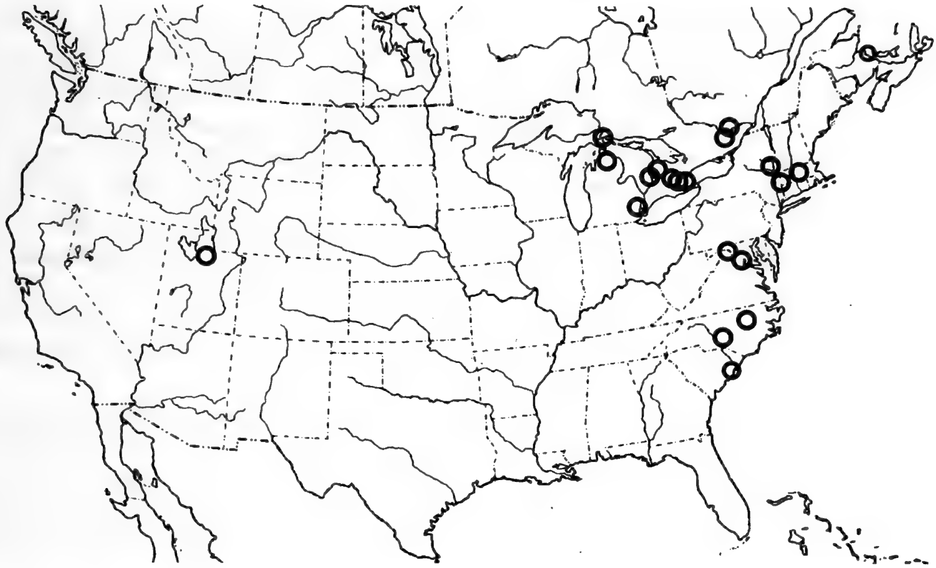
Male terminalia. (Figs. 21–23) Sternite 5 evenly setose. Sclerites of annulus well-developed. Epandrium as wide as long and almost as high as wide. Surstylus short, rounded, thick, and slightly pointed apically; tubercle-like bristles along entire length of apical and posterior margins, somewhat encroaching upon posterior surface. Cerci projecting, somewhat emarginate and with one pair of longer central bristles. Hypandrial arm curved, widest distally, as long as ventral lobe and projecting at 60-70° basally; lobe with one minute and two long distal bristles. Phallapodeme long and relatively thin. Pregonite long, tapered at both ends and with five medial bristles. Postgonite minute. Basiphallus large with epiphallus at tip. Distiphallus approximately 2/3 length of phallapodeme and bent at midpoint; lateral lobe well-developed, curved, and toothed distally; thumb well-developed.

Distribution. Canada: NB, ON, PQ. United States: MA, MI, NC, NH, NY, SC, UT (northeastern North America and Utah) (Map 10).

Holotype. UNITED STATES, MI: Grosse Ile, **Wayne Co.**, 29 August 1948, G. Steyskal, ♂, USNM.

Paratypes examined. CANADA, ON: Bells Corners, ex. Rotten log, 21 June 1954, E. C. Becker, 2♂, ♀, USNM; Bells Corners, 12 June 1954, E. C. Becker, reared ex. puparia on rotten log, 2♂, 2♀, CNCI; Burke Falls, 13 July 1926, F. P. Ide, ♀, CNCI; nr. Picton, 9 July 1970, J. F. McAlpine, ♀, CNCI. **PQ:** Hull, 10 August 1965, ex. Malaise trap, ♀, CNCI; Laniel, 28 July 1933, ♀, CNCI; Duncan Lk. Nr. Rupert, 1 August 1969, J. F. McAlpine, ♀, CNCI. **UNITED STATES.** White Mts., Morrison, ♂, USNM.

Additional material examined. CANADA, ON: Tenby Bay, Malaise at lake edge, 19 July 1992, ♀, DEBU; Hamilton, 10-13 July 1980, Malaise trap, M. Sandborne, ♂, 3♀, DEBU; Dundas, E. A. Menard, 27 June 1980, ♂, 2♀, DEBU; 13 June 1980, ♂, ♀, DEBU; 17 June 1980, ♂, ♀, DEBU; 1 July 1980, 2♂, DEBU; 23 June 1980, ♀, DEBU; 8 July 1980, ♂, DEBU; 15 July 1980, ♂, DEBU; reared in dead Elm, May 1980, ♂, DEBU; Dornoch, fen, 20 July 1996, S. A. Marshall, ♂, DEBU; Port Franks, Watson property nr. lake, pans, 8-12 July 1996, J. Skevington, ♀, DEBU; Sault Ste. Marie, Bristol Pl. Pk., sweeps, mostly *Impatiens, Clematis, Rubus*, grasses, 46°30.8'N, 84°16.6'W, 11 June 1999, K. N. Barber, ♀, DEBU; Fergus, Malaise trap, S. A. Marshall, 5 July 1990, ♀, DEBU; 4 August 1990, ♀, DEBU; 9 July 1990, ♀, DEBU; (yard) flood plain, Malaise trap, 27 June 1985, S. A. Marshall, ♀, DEBU; Guelph, K. N. Barber, 11 July 1979, ♀, DEBU; 9 July 1979, ♀, DEBU; pan traps, 5-18 July 1980, 2♀, DEBU; Brown & Marshall, University of Guelph Arboretum, Malaise head, 28 June–4 July 1983, ♀, DEBU; Arkell, E. A. Innes, 7 May 1979, ♀, DEBU; 7 May 1979, (emerged 22 May 1979), ♀, DEBU; 8 May 1979 (emerged 22-30 May 1979), 41♂, 22♀, DEBU. **UNITED STATES, MD:** Colesville, W. W. Wirth, 4 July 1976, ♀, USNM; 11



MAP 10. Distribution of *Sobarocephala latifacies* Sabrosky & Steyskal.

July 1974, ♂, USNM; 18 June 1977, ♂, USNM; **Montgomery Co.**, Carderock Pk., 13 June 1970, L. V. Knutson, ♀, USNM; **Prince Georges Co.**, Patuxent Wildlife Res. Centre, W. W. Wirth, 14 July 1978, ♀, USNM. **MI: Wayne Co.**, Grosse Ile, 30 June 1949, G. Steyskal, 2♀, USNM. **NC: Cumberland Co.**, Ft. Bragg, 28 May–3 June 1967, J. D. Birchim, ♀, CASC; **Wake Co.**, 7 air mi SW of Raleigh off rd., 30 August 1985, C. S. Parron, Malaise trap, ♂, NCSU. **NY: Rensselaer Co.**, 11-22 July 1966, P. &.B. Wygodzinsky, ♀, AMNH. **SC: Georgetown Co.**, Hobcaw Barony, Belle Baruch Marine Field Lab, on slime mold, May 2004, S. A. Marshall, ♀, DEBU [in alcohol]. **UT: Summit Co.**, Coalville, 1710 m, 30 July 1973, P. H. Arnaud Jr., ♀, CASC.

Comments. The abdominal pattern of the female is characteristic, but the male abdomen is entirely yellow, similar to that of several other North American species. Males can be best diagnosed by a frons that narrows posteriorly, an absence of white shoulder patches, and an open cell bm.

***Sobarocephala latifrons* (Loew, 1860)** (Figs. 10, 48–50; Map 11)

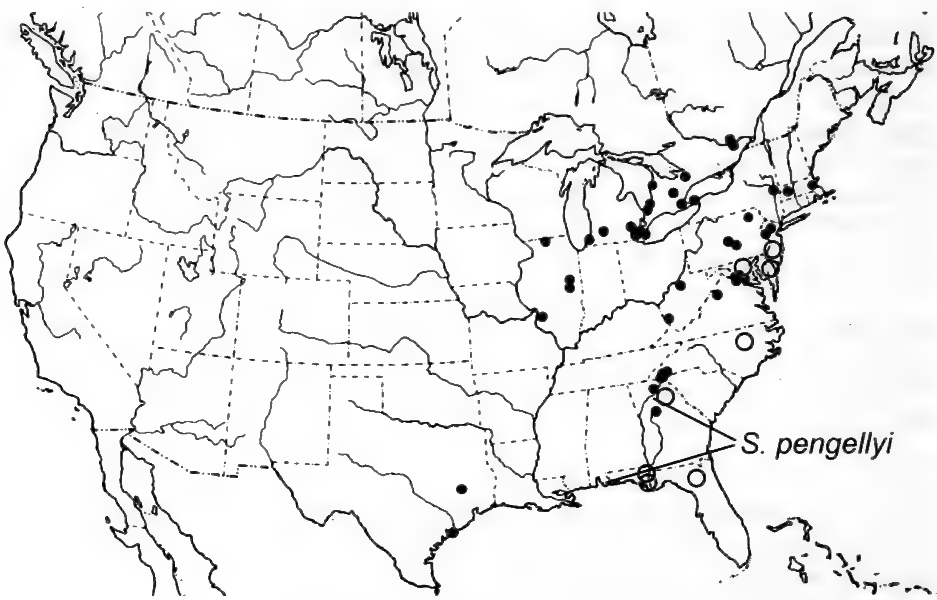
Heteroneura latifrons Loew, 1860: 82.
Heteromeringia latifrons, Johnson, 1913: 99. Malloch, 1918: 8.
Sobarocephala latifrons, Melander & Argo, 1924: 42. Sabrosky & Steyskal, 1974: 381.

Redescription (Fig. 10)

Male. Body length 3.3-4.5 mm. Bristles black. Two dorsocentral bristles plus one minute bristle in front of anterior dorsocentral. Acrostichal bristle present. Small, weak presutural intra-alar bristle sometimes present. Lateral scutellar bristles weak. Arista sparsely plumose. Sides of frons parallel. Scutum predominantly yellow with notopleuron brown and lateral margin behind suture light brown. Scutellum yellow with median brown stripe (darkest apically and sometimes faded basally). Laterotergites sometimes light brown lateral to scutellum. Pleuron and legs white with fore tarsi light brown. Head predominantly yellow, with face light yellow, ocellar spot large and triangular, and mouthparts, parafacial and gena white; gena pilose. Abdomen light yellow, often light brown on tergite 5 and laterally on tergites 2-4, and sometimes with small spot at base of epandrium. M_{1+2} ratio 3.8-4.4. Wing clear. Cell bm open. Face flat.

Female. Similar to male except as follows: lateral brown margin on scutum wider; fore tarsi brown; scutellar stripe and lateral stripes on laterotergites strong and always present; laterotergites with thin stripe below scutellum; tergites 2-4 brown laterally, medially, on posterior margin and laterally on anterior margin; tergite 5 sometimes with wide median stripe (tapering anteriorly); tergite 6 and anterior margin of tergite 7 brown; wing dusky along anterior margin.

Male terminalia. (Figs. 48–50) Sternite 5 evenly setose. Sclerites of annulus well-developed. Epandrium as wide as high and length 4/5 height. Surstylus 4/5 height of epandrium and with rounded emargination from midpoint of posterior margin to apex



MAP 11. Distribution of *Sobarocephala latifrons* (Loew) (dot), *S. wirthi* spec. nov. (circle) and *S. pengellyi* spec. nov.

(appearing "hook-like"); tubercle-like bristles along posterior and apical margins. Cerci small and rounded with one slightly longer central bristle. Hypandrial lobe with three short distal bristles. Phallapodeme and postgonite well-developed. Pregonite elongate and ovate with four basal bristles, and with thin elongate projection on inner-medial surface. Basiphallus and epiphallus small. Distiphallus 2/3 length of phallapodeme; thumb and lateral lobe well-developed with lobe half length of distiphallus.

Distribution. Canada: ON, PQ. United States: DC, GA, IL, MA, MD, MI, NC, NJ, NY, PA, TX, VA, WV (Map 11).

Holotype. UNITED STATES, DC: "Osten Sacken", ♀, location unknown.

Paratype. UNITED STATES, VA: Fairfax Co., Dead Run, 22 June 1915, R. C. Shannon, ♂, USNM.

Additional material examined. 103♂, 153♀ AMNH, [CASC, CNCI, DEBU, EMUS, TAMU, TAUI, USNM].

Comments. *Sobarocephala latifrons* is a commonly collected species in northeastern North America south of Ottawa and east of the Mississippi. Specimens have also been found in North Carolina, Georgia, and Texas. The only similar species with an overlapping range is the closely related *S. wirthi*, which is more southeastern in distribution. Males of these two species are distinct (see couplet 13), but females are more difficult to separate.

***Sobarocephala muesebecki* Sabrosky & Steyskal, 1974** (Figs. 7, 36–38; Map 1)

Sobarocephala muesebecki Sabrosky & Steyskal, 1974: 378.

Redescription (Fig. 7)

Male. Body length 2.6-4.1 mm. Bristles brown. Two dorsocentral bristles plus one minute bristle in front of anterior dorsocentral. Acrostichal bristle absent. Two pairs of well-developed lateral scutellar bristles. Arista densely plumose. Sides of frons parallel. Body yellow with fore tibia and tarsi light brown, ocellar spot and infuscation at base of arista brown, epandrium dark brown, and coxae, gena, parafacial, and anterior (or lateral) margin of frons usually white; sometimes lateral half of postpronotum brown (Alabama), or postpronotum and notopleuron brownish (some North Carolina specimens). Occiput usually pilose. M_{1+2} ratio 4.0-4.5. Wing lightly clouded along R_{2+3} on distal 1/3. Cell bm open. Face flat.

Female. Externally similar to male except as follows: fore tibia light brown; hind tibia and tarsi sometimes browned (Alabama, Florida, North Carolina); tergites 3, 4, and posterior margin of tergite 2 with central stripe; tergites 5-7 brown; tergite 8 brown or with anterior half light brown.

Male terminalia. (Figs. 36–38) Similar to *S. atricornis* (Figs. 33–35), except surstylus broader at base, tubercle-like bristles densely arranged along surstylus, pregonite

widest basally, and lateral lobe strongly bent medially with small swelling at base of thumb; thumb short, pointed, and projecting at 90°.

Distribution. United States: AL, FL, NC, NJ, PA, TX (Map 1).

Holotype. UNITED STATES, FL: Levy Co., 7 mi NE of Cedar Key, 1 June 1970, D. L. Bailey, ♂, USNM.

Allotype. UNITED STATES, FL: same collection as holotype, ♀, USNM.

Paratypes examined. UNITED STATES, FL: Levy Co., 7 mi NE of Cedar Key, 1 June 1970, D. L. Bailey, ♂, USNM; ex. Malaise, 18 May 1970, ♀, USNM.

Additional material examined. UNITED STATES, AL: Baldwin Co., Bon Secour Nat. Wildlife Refuge, 5-7 May 1994, S. A. Marshall, 2♀, DEBU. **FL: Santa Rosa Co.**, Blackwater R. St. Forest, 23 June 1973, W. W. Wirth, ♀, USNM; **Levy Co.**, 7 mi NE Cedar Key, 1 June 1970, D. L. Bailey, ♂, ♀, USNM; Cedar Key, ex Malaise trap, 18 May 1970, D. L. Bailey, ♀, USNM; **Highlands Co.**, Archbold Biol. Stn., 11 October 1964, P. H. Arnaud Jr., 4♀, CASC; 23 April 1967, B. V. Peterson, ♀, CNCI. **NC: Columbus Co.**, Lk. Waccamaw, 6 July 1985, W. Steiner & A. Gerberich, ♀, USNM; **Cumberland Co.**, Fort Bragg, J. D. Birchim, 23-25 August 1967, ♀, CASC; 16 August 1967, ♀, CASC; **Bladen Co.**, Singletary Lk. St. Pk., 34°35'0N, 78°27'30W, Malaise, 19-22 May 2003, Marshall & Paiero, 6♀, DEBU. **NJ:** Oswego Lk., **Burlington Co.**, 30 August 1974, Menke & Miller, 4♀, USNM. **PA:** State College, **Centre Co.**, 4 July 1972, D. J. Shetlar, ♀, CASC. **TX:** Salmon, **Anderson Co.**, 22 June 1974, H. R. Burke, Malaise trap, ♂, TAMU; 1-8 July 1974, ♂, 2♀, TAMU; 1 June 1974, ♂, 5♀, TAMU; **Anderson Co.**, 10 mi SW Elkhart, H. R. Burke, modified Malaise, 5-6 June 1976, ♀, TAMU; **Brazos Co.**, College Stn., Wharton, Malaise trap, 20 September–4 October 1974, ♂, TAMU; 22 July–2 August 1974, 4♀, TAMU; 14-21 July 1974, 5♂, 2♀, TAMU; **Montg. Co.**, Jones St. Forest, 8 mi S Conroe, 28 June–13 July 1987, Wharton, Steck & Carroll, 2♀, TAMU; 21-27 June 1987, Wharton, Steck & Carroll, ♀, TAMU; 1-7 June 1987, Wang, Wharton & Praetorius, Malaise trap, ♀, TAMU; 28 April–13 July 1987, Steck, Wharton & Carroll, 3♀, TAMU.

Comments. See comments for *Sobarocephala affinis*.

***Sobarocephala pengellyi* spec. nov.** (Figs. 12, 42–44; Map 11)

Description (Fig. 12)

Male. Body length 2.9-3.8 mm. Bristles brown. Two dorsocentral bristles plus one minute bristle in front of anterior dorsocentral. Acrostichal bristle present. Two pairs of well-developed lateral scutellar bristles. Arista sparsely plumose. Sides of frons parallel. Scutum yellow with lateral margin brownish behind light brown notopleuron; scutellum with thin light brown central stripe extending onto base of scutum. Pleuron light yellow with anepisternum and anterior face of katepisternum yellow. Coxae white. Legs light yellow

with fore tarsi light brown. Head yellow with face light brown centrally, gena and parafacial white and pilose, occiput white and ocellar tubercle brown. Abdomen predominantly yellow with wide light brown central stripe on tergites 2-4 (tapering anteriorly on each tergite) and epandrium brown (lighter on distal half). M_{1+2} ratio 3.0. Wing clear or with light apical cloud around R_{2+3}. Cell bm open. Face flat.

Female. As described for male except as follows: scutum with one pair of light brown lateral spots at base; scutellar stripe most pronounced apically (sometimes continuing onto base of scutum); laterotergite sometimes with light brown stripe lateral to scutellum and one stripe below; fore tarsi brown; face yellow (sometimes with orange tint); central stripe on tergites 2-4 brown, thin, and of equal width along length; tergites 5-7 brown and sternites 6 and 7 brown.

Male terminalia. (Figs. 42–44) Sternite 5 evenly setose. Sclerites of annulus well-developed. Length, height, and width of epandrium subequal; tapered to base. Surstylus 7/10 height of epandrium and broadly rounded; tubercle-like bristles along apical and posterior margins. Cerci small, rounded, and slightly projecting. Hypandrium with arm and ventral lobe subequal in length, and ventral lobe with two short medial bristles and one minute distal bristle. Phallapodeme and basiphallus well-developed. Epiphallus minute. Pregonite large and ovate with five central bristles. Postgonite absent. Distiphallus 7/10 length of phallapodeme; lateral lobe strongly bent, spinulose distally, with broad flat medial lobe, and with thumb absent.

Distribution. United States: AL, GA (Map 11).

Holotype. UNITED STATES, GA: Forsyth, 2 June 1970, ♂, CNCI.

Paratypes. UNITED STATES, AL: Baldwin Co., Raft River Tributary, 16 October 2001, 30.52.261N, 87.56.934W, J. W. McCreadie, 2♀, DEBU. **GA:** same collection as holotype, 10♀, CNCI.

Comments. *Sobarocephala pengellyi* can be distinguished from congeners by a black epandrium, one pair of lateral subbasal spots on the female scutum, a light facial spot, a relatively short surstylus, and a characteristic lateral lobe on the distiphallus.

Etymology. The specific name is a patronym dedicated to the late D. H. Pengelly, a great entomologist whose spirit lives on in the community of entomologists associated with "his" insect collection, the University of Guelph Insect Collection.

***Sobarocephala quadrimaculata* Soós, 1963** (Figs. 1, 27–29; Map 3)

Sobarocephala nitida Soós, 1963: 393.
Sobarocephala quadrimaculata Soós, 1963: 394. Sabrosky & Steyskal, 1974: 374.

Redescription (Fig. 1)

Male. Body length 2.9-4.4 mm. Bristles yellow with lateral scutellar bristles dark

brown. Two dorsocentral bristles. Acrostichal bristle absent. Two pairs of well-developed lateral scutellar bristles. Ocellar bristle absent. Arista densely plumose. Sides of frons converging posteriorly. Scutum yellow with one pair of short transverse presutural spots behind postpronotum and one pair of large, quadrate, postsutural spots on lateral margin; small triangular spot sometimes in front of scutellum. Scutellum and laterotergites dark brown. Pleuron yellow. Coxae white. Legs yellow with fore tibia and tarsi brown; fore tibia and basal 2/3 of fore tarsomere 1 yellow in lighter specimens; hind tibia sometimes light brown. Head yellow with parafacial and (sometimes) gena white, first flagellomere with brown dorsal stripe, and ocellar tubercle brown. Abdomen yellow with epandrium and tergites 2 (medially), 3, 4, 5 (medially) and 6 brown. M_{1+2} ratio 4.0-4.2. Wing lightly clouded in cell R_1 and around bm-cu, and with dark infuscation distally on R_{2+3} (appearing "smudged" to R_{4+5}). Cell bm closed. Face convex on dorsal half below antennal bases.

Female. Externally as described for male except tergite 1 with large oval spot and abdomen past tergite 6 yellow. Female from Alabama with scutellum yellow medially.

Male terminalia. (Figs. 27–29) Sternite 5 evenly setose. Annulus with sternites 6 and 7 reduced to thin but well-sclerotized band ventrally. Epandrium as wide as high and almost as long as high. Surstylus rectangular; tubercle-like bristles long, curved, and terminal. Cerci flat with one longer central bristle. Hypandrial arm relatively long and sharply angled with base projecting at 90° basally; ventral lobe wide, slightly shorter than arm, and with one minute and two long distal bristles. Phallapodeme well-developed with head reduced. Pregonite long, thin, and setulose medially and apically. Postgonite small, rounded, and setulose. Basiphallus small. Epiphallus long and thin. Distiphallus ¾ length of phallapodeme and wide distally (appearing "spoon-shaped"); lateral lobe large, broad, and serrate distally, with thumb absent.

Distribution. Bahamas, Colombia, Costa Rica, Mexico, Nicaragua, Panama, United States (AL, FL, GA, TX) (Map 3, in part).

Holotype. UNITED STATES, FL: ♀, USNM.

Additional material examined. COSTA RICA. Guanacaste: 14 km S Canas, F. D. Parker, 19-28 February 1990, ♀, EMUS; 5-10 August 1990, ♂, EMUS; 20-30 October 1989, ♂, EMUS; 28 July 1991, ♂, EMUS; 1-7 April 1991, ♂, 5♀, EMUS; 8-15 February 1991, 2♂, 3♀, EMUS; 20-24 March 1989, ♀, EMUS; 16-22 February 1990, ♂, 3♀, EMUS; 1-5 August 1992, ♀, EMUS; 19-28 February 1990, ♂, 2♀, EMUS; 1-15 July 1991, ♂, EMUS; 16-26 January 1990, ♂, EMUS; 24-31 May 1990, 2♂, EMUS; 23-28 February 1990, 7♂, EMUS; 5-11 January 1991, ♂, EMUS; 1-10 July 1991, ♀, EMUS; 2-4 June 1991, ♀, EMUS; 9-14 February 1989, ♀, EMUS; 3 km SE R. Naranjo, F. D. Parker, 15-25 January 1993, ♀, EMUS; 21 July 1993, ♀, EMUS; 11-20 December 1992, ♀, EMUS; S Canas, F. D. Parker, 7-10 March 1989, ♀, EMUS; 28 July 1991, ♀, EMUS; 21-25 January 1989, 2♀, EMUS; 9-14 February 1989, ♂, EMUS; Santa Cruz, P. N. Marino Las Baulas, 0 m, 14 December 2000, Malaise, Y. Cardenas, ♀, INBC. **Heredia:** LaSelva Res. Sta., 11-17 June 1986, W. Hanson & G. Bohart, ♂, EMUS. **Limon:** Cuatro Esquinas, P. N. Tortuguero, 0 m, September 1989, J. Solano, ♀, INBC. **Puntarenas:** Pen. De Osa, Puerto Jimenez, 10 m, P. Hanson, January 1991, ♀, DEBU; May 1991, ♂, DEBU; November 1991, ♀,

DEBU; May 1992, ♂, DEBU; 5 km N Puerto Jimenez, 10 m, May 1991, P. Hanson, ♂, 2♀, DEBU; Malaise trap, June–July 1990, ♀, USNM. **COLOMBIA.** Tol. Armero, Malaise trap, 30 January–5 February 1977, E. L. Peyton, ♀, USNM. **HONDURAS.** Roatin Isl., 27 February 1979, G. E. Bohart, ♀, EMUS, Roatin Isl (west), 1 January 1980, 2♀, EMUS. **MEXICO.** Jalisco: Puerto Vallarta, 1 January 1971, sea level, P. H. & N. Arnaud, ♀, EMUS; Puerto Vallarta, G. E. Bohart, 10 December 1988, ♀, EMUS; 8 December 1984, ♂, EMUS; Quint. Roo, sweeping, F. Carillo, 10-14 October 1986, 2♂, EMUS. **NICARAGUA.** Puerto Rabezas, July 1971, J. Maldonado, ♀, USNM. **UNITED STATES, AL: Mobile Co.**, Chunchula (site 20), Malaise, 25 October 2004, 30.90N, 88.20W, E. Benton, 2♀, DEBU. **FL:** Royal Palm Pk., 29 January 1933, A. L. Melander, ♀, USNM; Gainesville, 8-22 December 1986, hardwood forest, Malaise trap, W. Mason, ♂, ♀, CNCI. **GA:** Georgia: **Liberty Co.**, St. Catherine's Island, 18-21 September 1972, F. C. & B. J. Thompson, ♀, AMNH. **TX:** Austin, 28 October 1951, M. R. Wheeler, ♀, AMNH.

Comments. *Sobarocephala quadrimaculata* is a relatively common species from Florida and Mexico to Colombia.

***Sobarocephala setipes* Melander & Argo, 1924** (Figs. 15, 59–61; Map 12)

Sobarocephala setipes Melander & Argo, 1924: 47. Sabrosky & Steyskal, 1974: 384.

Redescription (Fig. 15)

Male. Body length 2.4-2.9 mm. Bristles light brown. Two dorsocentral bristles plus one minute bristle in front of anterior dorsocentral. Acrostichal bristle absent. Two pairs of well-developed lateral scutellar bristles. Arista sparsely plumose. Sides of frons parallel. Scutum yellow with posterior corner of notopleuron and (often) one pair of wide basal stripes brown. Scutellum yellow (sometimes with brownish central tint). Laterotergites brown lateral to scutellum; yellow in specimens from Florida and holotype with posterior notal stripes also absent. Pleuron yellow, with meron and posterior half of katepisternum white. Legs yellow, with coxae and basal half of femora white and fore tarsi light brown to brown. Head predominantly yellow, with gena, parafacial, and occiput white and pilose, ocellar tubercle brown, and light infuscation sometimes around base of arista. Abdomen yellow with wide stripe on tergites 2-5 (also tergite 6 in one FL male). M_{1+2} ratio 3.2-3.7. Wing clear. Cell bm open. Face flat.

Female. Similar to male except as follows: anterior half of notopleuron and postpronotum sometimes brown; notopleuron with central light brown spot; tergite 6 with wide central stripe. One female from Florida (CNCI) with distal 2/3 of fore tibia brown, and several females from Québec with fore tibia light brown. Ontario specimens sometimes with corners of scutellum brown.

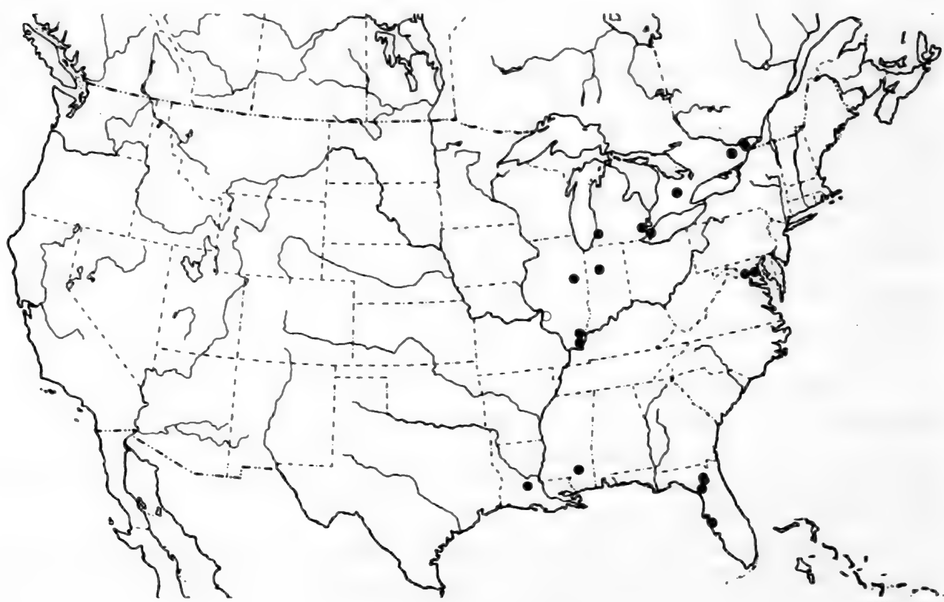
Male terminalia. (Figs. 59–61) Sternite five with comb of bristles on posteromedial margin. Annulus reduced to thin band ventrally. Epandrium as high as wide and length 3/5 height. Surstylus short and rounded; tubercle-like bristles absent. Cerci small, rounded, slightly sunken below distal margin of epandrium, and bristles short and subequal in length. Hypandrial arm short, thin and projecting distally; three minute distal bristles on ventral

lobe. Phallapodeme thin and shorter than length of hypandrium. Pregonite clavate with one distal bristle. Postgonite minute. Basiphallus 1/3 length of phallapodeme. Epiphallus absent. Distiphallus ¼ length of phallapodeme; lateral lobe small and ovate with thumb absent.

Distribution. Canada: ON. United States: FL, IL, IN, LA, MD, MI, MS (Map 12).

Holotype. UNITED STATES, MD: Marlboro, 19 June 1916, R. C. Shannon, ♂, USNM.

Additional material examined. CANADA, ON: Wellington Co., University of Guelph Arboretum, ex. dung, 8 August 2004, J. Klymko, ♂, DEBU [in alcohol]; 9 August 2004, O. Lonsdale, 2♀, DEBU [in alcohol]; 12 August 2004, O. Lonsdale, 3♂, ♀, DEBU [in alcohol]; 19 July 2005, O. Lonsdale, ♂, DEBU [in alcohol]; **Essex Co.**, Point Pelee N. P., forested area by west beach, Malaise trap and pans, 10-21 July 1999, O. Lonsdale, ♂, DEBU; Carleton Place, 27 July 1959, J. G. Chillcott, ♀, CNCI; Ottawa, J. R. Vockeroth, 13 August 1974, ♂, CNCI; 28 July 1964, ♀, CNCI; damp second-growth *Acer-Betula* wood, 11 July 1991, ♀, CNCI; 16 July 1991, ♀, CNCI; 3 August 1992, ♀, CNCI; Perth Rd., Rideau Tr., 14 July 1981, H. J. Teskey, ♀, CNCI; North Gower, 10 August 1984, D. Bell, ♀, CNCI. **UNITED STATES, FL:** Gulf Hammock, 23 April 1952, G. Peck, ♀, CNCI; **Sarasota Co.**, Myakka R. St. Pk., 21 May 1973, W. W. Wirth, Malaise trap, ♀, USNM; **Alachua Co.**, Pierce's homestead, W. H. Pierce, 13 October 1973, Malaise trap, ♀, USNM; Alachua Co., Chantilly Acres, 25 April 1970, W. W. Wirth, Malaise trap, ♀, USNM; Gainesville, Doyle Corner



MAP 12. Distribution of *Sobarocephala setipes* Melander & Argo.

Bldg., 23 September 1973, H. V. Weems Jr., Malaise trap, ♀, USNM. **IL: Champaign Co.**, Brownfield Woods, 2 mi NE Urbana, 26 June 1976, C. T. Maier, ♀, EMUS; Equality, 11 September 1952, M. R. Wheeler, 2♀, AMNH. **IN:** La Fayette, 2 July [year not given] , ♀, USNM; La Fayette, J. M. Aldrich, 5 August [year not given], ♀, USNM; 31 July [year not given], ♀, USNM; 23 July [year not given], ♀, USNM; 1 August [year not given], ♀, USNM. **LA:** Chicot S. Pk. nr. Ville Platte, September 1954, M. Wheeler, ♀, USNM. **MD: Montg'y Co.**, Dickerson, 14 July 1974, G. A. Foster, ♂, ♀, USNM; Glen Echo, J. R. Malloch, 16 July 1922, ♂, ♀, USNM; 9 July 1922, ♀, USNM; 2 July 1922, 2♂, USNM. **MI: Wayne Co.**, Grosse Isle, 21 July 1957, G. C. Steyskal, ♀, USNM; St. Joseph, **Berrien Co.**, 17 April 1972, D. D. Wilder, ♂, CASC. **MS: Forrest Co.**, 6 mi W Wiggins, Sweet Bay Bog, dung trap, 5-8 May 1994, sphagnum, S. A. Marshall, ♀, DEBU.

Comments. *Sobarocephala setipes* is largely sympatric with the similar *S. lachnosternum,* but *S. lachnosternum* occurs west into Saskatchewan, Lake Superior, Texas, and Utah (Map 9), and is not known from the southeastern United States.

Sobarocephala setipes is sometimes attracted to dung, and we have observed copulating pairs on dung baits in mid August in the University of Guelph Arboretum.

***Sobarocephala texensis* Sabrosky & Steyskal, 1974** (Figs. 17, 57, 58; Map 8)

Sobarocephala texensis Sabrosky & Steyskal, 1974: 381.

Redescription (Fig. 17)

Male. Body length 2.6 mm. Bristles brown. Two dorsocentral bristles. Acrostichal bristle absent. Two pairs of well-developed lateral scutellar bristles. Arista sparsely plumose. Sides of frons parallel. Thorax yellow with narrow light brown spot from base of scutum to center of scutellum. Legs yellow with fore tibia and tarsi brown. Head predominantly yellow, with occiput white, gena and parafacial white and silvery tomentose, first flagellomere with infuscation at base of arista and ocellar tubercle brown. Abdomen yellow with wide central stripe on tergites 2-5. M_{1+2} ratio 2.8-3.7. Wing lightly clouded along anterodistal margin. Cell bm open. Face flat.

Female. Externally as described for male.

Male terminalia. (Figs. 57, 58) Sternite five with comb of bristles on posteromedial margin. Sclerites of annulus well-developed. Epandrium as wide as high and length 2/3 height. Surstylus rounded and 2/5 height of epandrium; tubercle-like bristles absent. Cerci small, rounded, slightly sunken below distal margin of epandrium, and with all bristles short. Hypandrium with one minute distal and one short and one long medial bristle on ventral lobe; arm atrophied, distal, and projecting at acute angle to long axis of phallapodeme. Phallapodeme relatively thin. Pregonite rectangular with one distal bristle. Basiphallus well-developed. Epiphallus and postgonite small. Distiphallus 2/3 length of phallapodeme with lateral lobe well-developed.

Distribution. United States: TX (Map 8).

Holotype. UNITED STATES, TX: Rio Frio, Leakey, **Real Co.**, 23 May 1972, W. W. Wirth, ♂, USNM [not examined].

Allotype. UNITED STATES, TX: same collection as holotype, ♀, USNM.

Paratypes examined. UNITED STATES, TX: same collection as holotype, 2♂, ♀, USNM.

Comments. *Sobarocephala texensis* differs from the similarly coloured *S. setipes* (Fig. 15) in having a yellow thorax with a light median stripe on the scutellum that extends onto the base of the scutum.

***Sobarocephala wirthi* spec. nov.** (Figs. 11, 45–47; Map 11)

Description (Fig. 11)

Male. Body length 3.3-5.0 mm. Bristles dark brown. Two dorsocentral bristles plus one minute bristle in front of anterior dorsocentral. Acrostichal bristle present. Lateral scutellar bristles weak. Arista sparsely plumose. Sides of frons parallel. Notum yellow with notopleuron and (sometimes) postpronotum brown; supra-alar spot sometimes present (Georgia) and confluent with notopleural spot. Pleuron, coxae, and femora white, with yellow spot on anepisternum. Legs yellow (entirely yellow in Georgia specimens) with fore tarsi brown and fore tibia usually light brown to brown. Scutellum with brown apical spot (highly reduced in some North Carolina specimens) that is sometimes wide and attaining anterior margin of scutellum. Laterotergites variably coloured. Head yellow with face light yellow, ocellar tubercle brown, and parafacial, gena, and occiput white; gena pilose. Abdomen yellow, sometimes with lateral margins of tergites (2)3-5 lightly infuscated (Georgia). M_{1+2} ratio 3.3. Wing clear, but if scutellar stripe entire, wing dusky in cell R_1 and around distal 1/3 of R_{2+3}. Cell bm open. Face flat.

Female. Externally similar to male except as follows: central stripe on scutellum weak if entire; abdomen partly yellow, with tergite 6 brown, tergite 7 brown basally and laterally, and posterolateral margins of tergites 2-5 with light brown spots.

Male terminalia. (Figs. 45–47) Sternite 5 evenly setose. Sclerites of annulus well-developed. Epandrium as wide as high and with length 4/5 height. Surstylus as high as epandrium and subtriangular; tubercle-like bristles along posterior and apical margins. Cerci small and rounded with one pair of longer central bristles. Hypandrium with one minute distal and two long medial bristles on ventral lobe, sometimes with two minute distal bristles and three long medial bristles. Phallapodeme well-developed with head thin and recurved. Pregonite thin and elongate with four distal bristles. Basiphallus and postgonite small. Epiphallus as large as basiphallus in outline. Distiphallus half length of phallapodeme; lateral lobe well-developed with thumb short, thin, and strongly projecting.

Distribution. United States: DE, FL, GA, MD, NC, NJ (Map 11).

Holotype. UNITED STATES, MD: Montg'y Co., Colesville, W. W. Wirth, 11 July 1974, ♂, USNM.

Paratypes. UNITED STATES, DE: Rehoboth, W.W. Wirth, Malaise trap, 18 July 1972, ♂, ♀, USNM. **FL: Jackson Co.**, Florida Caverns State Pk., 26 May 1973, W. W. Wirth, Malaise, ♂, USNM; **Liberty Co.**, Torreya State Pk., 13 June 1974, H. V. Weems Jr. & C. R. Artaud, Malaise trap, ♀, USNM; 5 July 1965, H. V. Weems Jr., Malaise trap, ♀, USNM; **Alachua Co.**, Gainesville, Austin Cary Forest, G. B. Fairchild, 30 August 1976, ♀, USNM; 30 July 1976, ♀, USNM; 11 June 1976, insect flight trap, ♂, ♀, USNM. **GA:** Athens, 8-11 July 1969, R. & J. Matthews, Malaise, ♀, EMUS; Forsyth, 2 June 1970, 23♂, CNCI. **MD: Montg'y Co.**, Colesville, W. W. Wirth, 11 July 1974, ♂, 2♀, USNM; 4 July 1976, ♀, USNM; Malaise trap, 26 June 1977, ♀, USNM; 30 June 1977, ♂, USNM; Glen Echo, 25 June 1922, J. R. Malloch, ♀, USNM. **NC: Wake Co.**, 7 air mi SW of Raleigh off rd., C. S. Parron, Malaise trap, 17 July 1985, ♂, NCSU; 10 July 1985, 2♂, NCSU; 29 June 1985, ♀, NCSU; 31 July 1985, ♀, NCSU; 25 June 1985, ♀, NCSU; **Mecklenberg Co.**, 22 June 1996, T. Daggy, ♀, NCSU. **NJ:** Oswego Lk., **Burlington Co.**, 30 August 1974, Menke & Miller, ♀, USNM.

Comments. See comments for *Sobarocephala latifrons*.

Etymology. The specific name honours the late W. W. Wirth, who collected most of the type material.

Acknowledgements

We would like to thank a number of people for their aid in the preparation of this paper, including the curators who loaned us most of the material used in this study: T. Nguyen and D. Grimaldi (AMNH), K. Ribardo and N. Penny (CASC), C. Young (CMNH), D. M. Wood, J. R. Vockeroth, J. O'Hara, S. Brooks, J. Skevington, L. Bartels and J. Cumming (CNCI), W. Hanson (EMUS), M. Zumbado and M. Solis (INBC), P. Perkins (MCZC), R. Blinn (NCSU), E. Riley (TAMU), A. Freidberg (TAUI), and D. Furth, A. Norrbom and F. C. Thompson (USNM). W. Reeves (Center for Disease Control and Prevention, Atlanta, GA) graciously donated material from the southern United States. Comments provided by two reviewers were greatly appreciated. This study was supported by NSERC discovery grants awarded to Stephen Marshall, and NSERC and OGS grants awarded to Owen Lonsdale.

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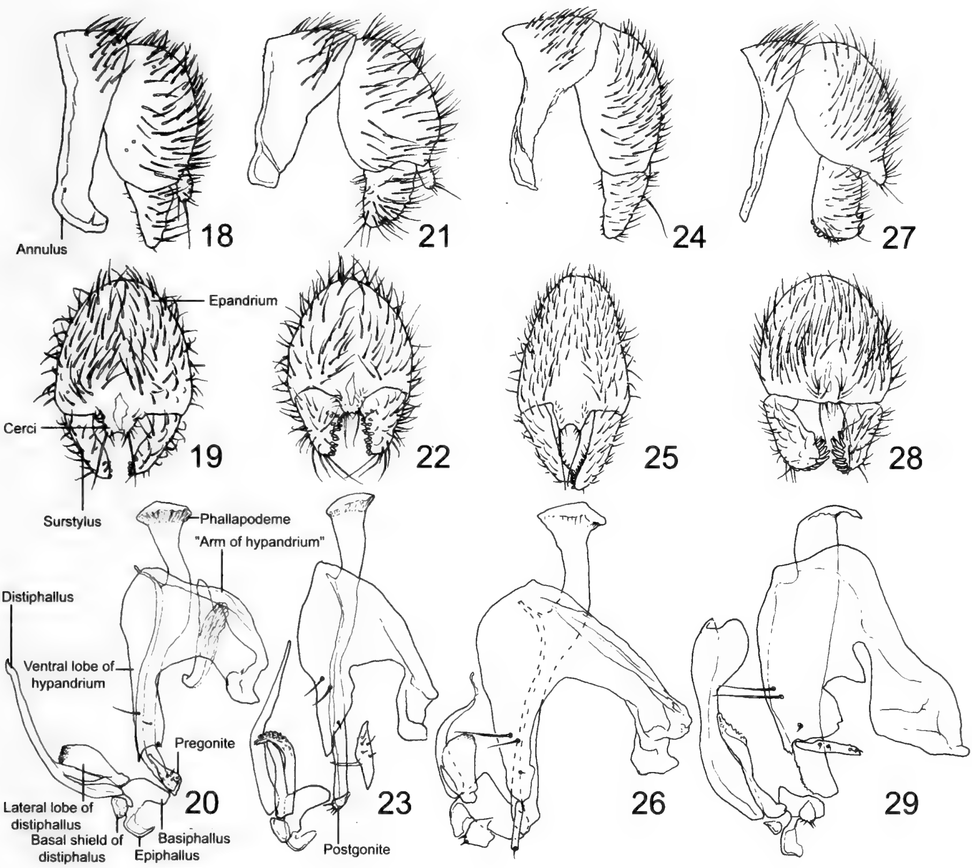
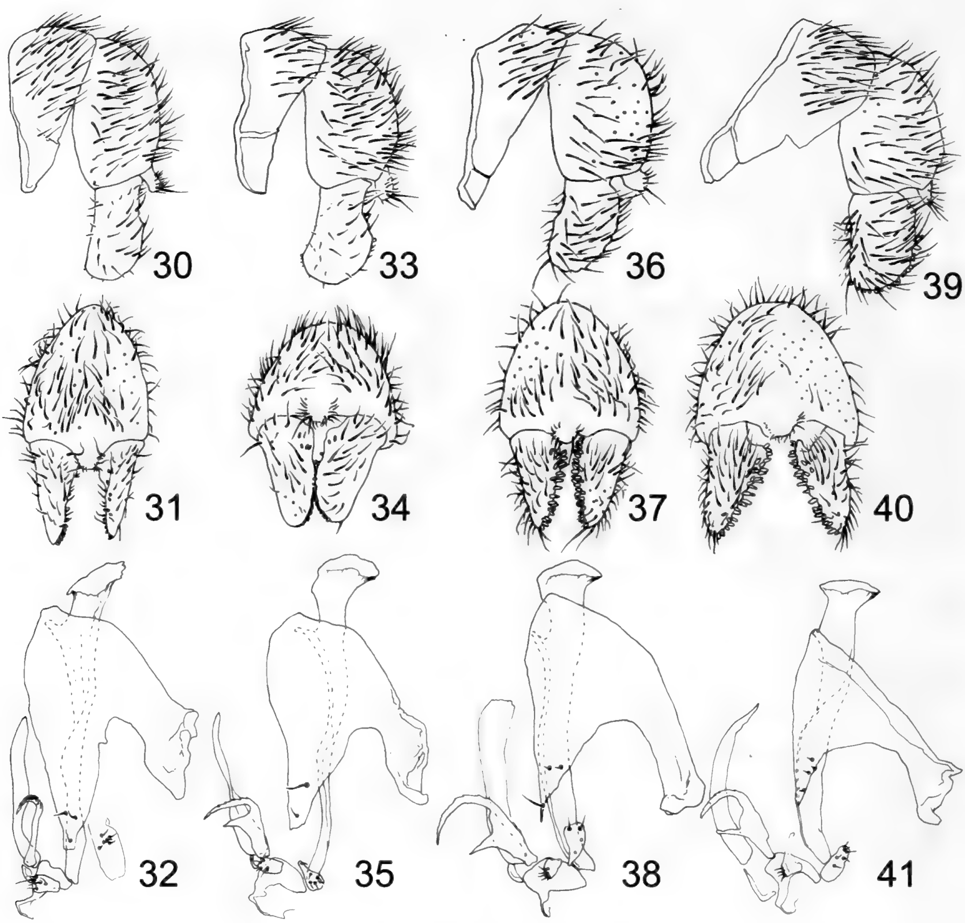
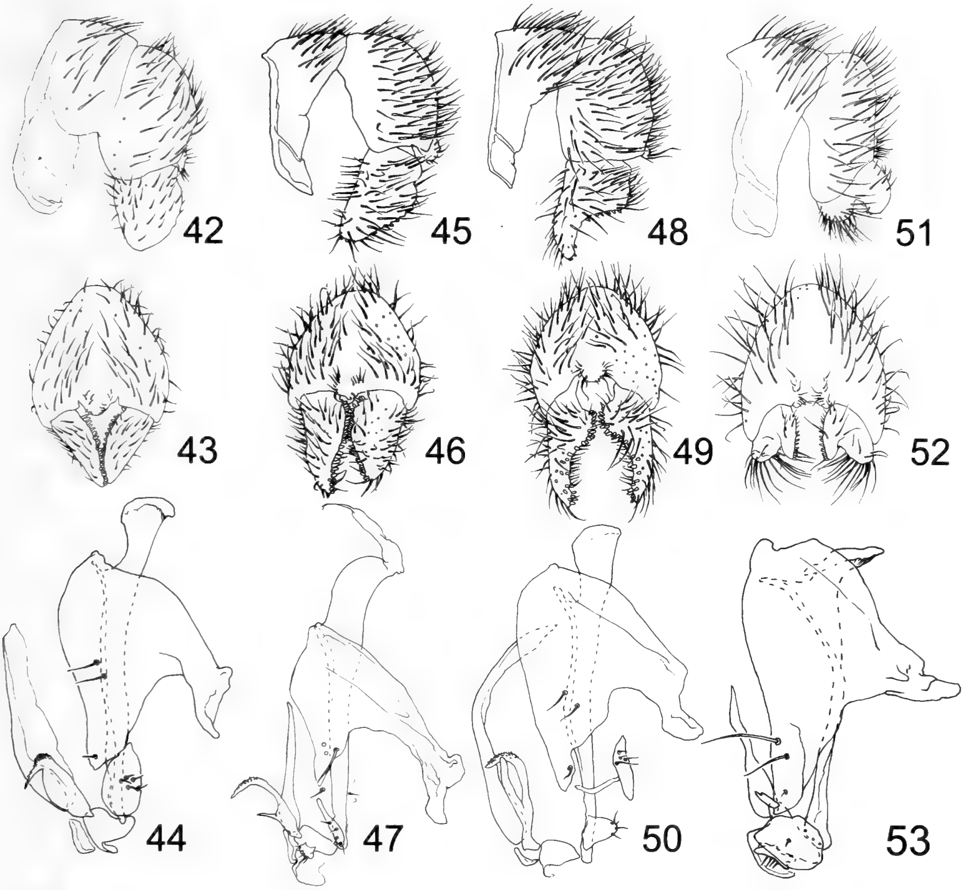


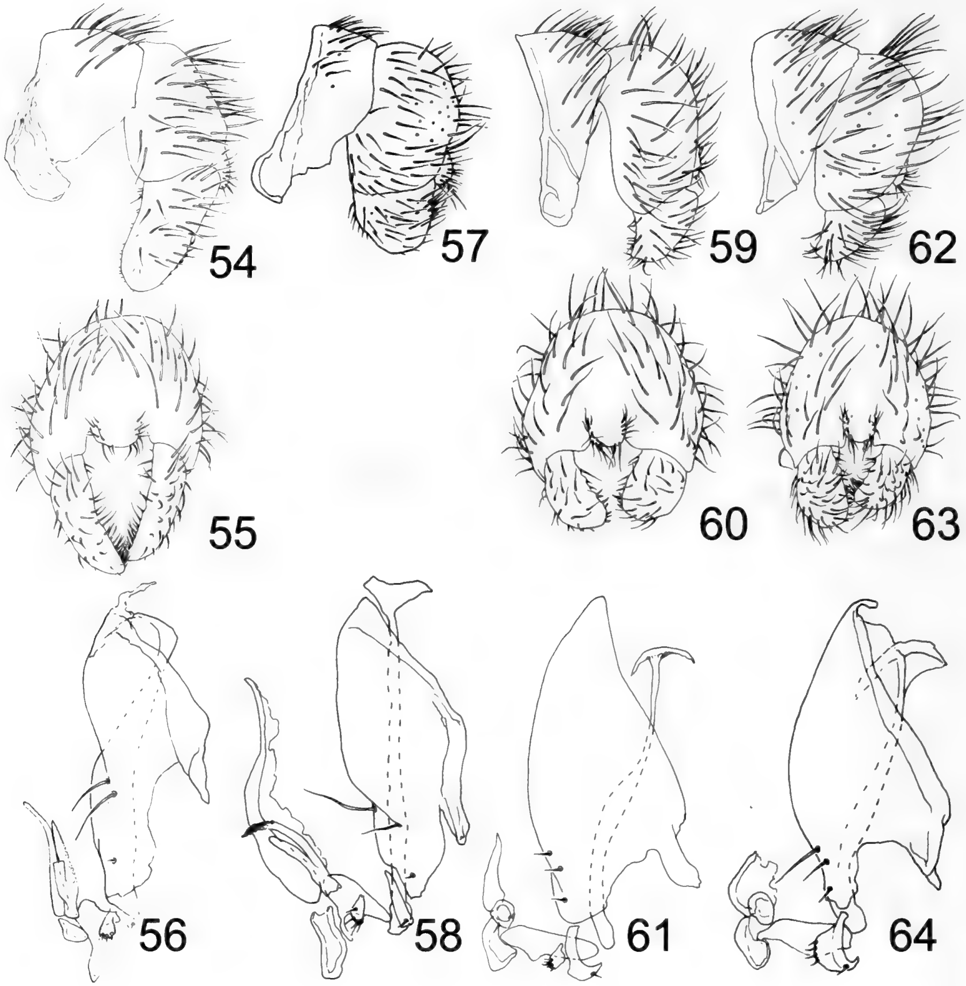
FIGURES 18–20. *Sobarocephala flaviseta* (Johnson), male terminalia. 18–external, left lateral. 19–external, posterior. 20–hypandrial complex, left lateral. FIGURES 21–23. *S. latifacies* Sabrosky & Steyskal, male terminalia. 21–external, left lateral. 22–external, posterior. 23–hypandrial complex, left lateral. FIGURES 24–26. *S. cruciger* Sabrosky & Steyskal, male terminalia. 24–external, left lateral. 25–external, posterior. 26–hypandrial complex, left lateral. FIGURES 27–29. *S. quadrimaculata* Soós, male terminalia. 27–external, left lateral. 28–external, posterior. 29–hypandrial complex, left lateral.



FIGURES 30–32. *Sobarocephala atricornis* Sabrosky & Steyskal, male terminalia. 30–external, left lateral. 31–external, posterior. 32–hypandrial complex, left lateral. FIGURES 33–35. *S. flava* Melander & Argo, male terminalia. 33–external, left lateral. 34–external, posterior. 35– hypandrial complex, left lateral. FIGURES 36–38. *S. muesebecki* Sabrosky & Steyskal, male terminalia. 36–external, left lateral. 37– external, posterior. 38–hypandrial complex, left lateral. FIGURES 39–41. *S. affinis* (Johnson), male terminalia. 39–external, left lateral. 40–external, posterior. 41–hypandrial complex, left lateral.



FIGURES 42–44. *Sobarocephala pengellyi* spec. nov., male terminalia. 42–external, left lateral. 43–external, posterior. 44–hypandrial complex, left lateral. FIGURES 45–47. *S. wirthi* spec. nov., male terminalia. 45–external, left lateral. 46–external, posterior. 47–hypandrial complex, left lateral. FIGURES 48–50. *S. latifrons* (Loew), male terminalia. 48–external, left lateral. 49–external, posterior. 50–hypandrial complex, left lateral. FIGURES 51–53. *Sobarocephala interrupta* Sabrosky & Steyskal, male terminalia. 51–external, left lateral. 52–external, posterior. 53–hypandrial complex, left lateral.



FIGURES 54–56. *Sobarocephala dreisbachi* Sabrosky & Steyskal, male terminalia. 54–external, left lateral. 55–external, posterior. 56–hypandrial complex, left lateral. FIGURES 57–58. *S. texensis* Sabrosky & Steyskal, male terminalia. 57–external, left lateral. 58–hypandrial complex, left lateral. FIGURES 59–61. *S. setipes* Melander & Argo, male terminalia. 59–external, left lateral. 60–external, posterior. 61–hypandrial complex, left lateral. FIGURES 62–64. *S. lachnosternum* Melander & Argo, male terminalia. 62–external, left lateral. 63–external, posterior. 64–hypandrial complex, left lateral.

A DECLINE IN THE NUMBER OF LONG-HORNED WOOD BORING BEETLE (COLEOPTERA: CERAMBYCIDAE) SPECIES IN ONTARIO DURING THE 20TH CENTURY?

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Abstract *J. ent. Soc. Ont.* 138: 107–135

Documenting loss of biodiversity in insects is hindered by the lack of species level inventories for many taxa. In Canada we have a better understanding of Coleoptera distributions than for most other taxa. Here we ask if we know how many species of Cerambycidae occur in Ontario, and whether there has been a change in the number of species over the past 100 years. More than 18,000 specimens collected since 1862 were examined. A species accumulation curve demonstrates that the inventory is reasonably complete. Rarefaction estimates of species richness by decade show that fewer species were collected after 1950 than before. Most of the 20 species collected only prior to 1950 were associated with hardwood trees in the Carolinian zone of extreme southern Ontario. Loss of forested habitat and replacement of old growth forests with younger forests may have played a role in the decline. Nine species were first collected after 1950, resulting in a net loss of 11 species. Selected records from after 2000 suggest that the introduction of species, range expansions into Ontario, and discovery or rediscovery of rare species is continuing.

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Introduction

Entomologists have difficulty documenting biodiversity losses because species-level inventories do not exist for most taxa for most locations. In Canada, only about 60-65% of all arthropod species that exist in the country have been documented (Danks 1979). For many insect groups we lack keys, comprehensive revisions, or the expert taxonomists able to identify species, undertake the revisions, and write the keys necessary for species identification; in short there is a 'taxonomic impediment' (Taylor 1983).

The insect fauna of Ontario is incompletely known, although two approaches, broad scale inventories and curation of existing collections, have expanded our knowledge in the past 20 years. These approaches have produced species-level inventories for a few

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locations (e.g. Skevington et al. 2001; Paiero et al. in press) and many newly recorded species in relatively well known taxa, such as aculeate Hymenoptera (Buck 2004; Buck et al. 2006), Hemiptera (Paiero et al. 2004), Orthoptera (Marshall et al. 2006), and Mecoptera (Cheung et al. 2006). For Cerambycidae, McCorquodale (2002) documented 14 new records for Ontario, including seven new records for Canada, and clarified the status of 11 other species for which there was equivocal evidence of occurrence in Ontario.

The Cerambycidae are plant-feeding beetles with about 1,100 species in North America (Linsley 1961; Linsley and Chemsak 1997; Allison et al. 2004). A series of taxonomic monographs by Linsley (1962a; 1962b; 1963; 1964), Linsley and Chemsak (1972; 1976; 1985; 1995), and Chemsak (1996), as well as a recent field guide, make taxonomic information accessible (Yanega 1996). Although most species of Cerambycidae in North America are well known taxonomically, new taxonomic notes on the genus *Oberea* (Yanega 1996) and current work on *Tetropium* by Serge Laplante, Canadian National Insect Collection, indicate that systematics work is still required.

Most cerambycids depend on tree or shrub hosts for development. Therefore host availability and changes in host distribution and abundance should influence the distribution and abundance of these beetles. In Ontario, land use and forest cover have changed dramatically over the past 300 years, particularly south of the Canadian Shield (Keddy 1997; Larson et al. 1999; Armson 2001; Suffling et al. 2003). Forests were converted to agricultural fields and timber was extracted from large areas during the 1800s; forest area was at a minimum in the 1920s, with about 10% of the original forest cover remaining south of the Canadian Shield (Larson et al. 1999). Besides the loss of forested area, there has been a change in the character of forests. Larson et al. (1999) explain that forests in southern Ontario are younger, more fragmented, and more homogeneous now compared to 300 years ago. North of the French and Mattawa Rivers, the area of forest cover has changed less dramatically, but composition of the forest has changed through forest harvesting (Jackson et al. 2000).

Land use change is expected to change the insect fauna. About 60% of nationally listed species of vertebrates and vascular plants occur in Ontario, with most of these occurring only in Ontario and only in the Carolinian or Deciduous Forest zone (Canadian Wildlife Service 2006). Habitat loss through clearing for agriculture and urbanization are prime factors.

Here we ask whether there is a good inventory of the Cerambycidae in Ontario. Given that recent work on a variety of groups has increased the number of species known for Ontario, it is important to assess the completeness of our inventory. Next, because of land use changes and decrease in older forests, we ask whether there are fewer species represented in collections from 1950 to 1999 compared to before 1950. At a finer level, the same question is asked for eight shorter time periods, roughly decades, four before 1950 and four from 1950–1999. Host preferences and geographic range of the species in collections only from before 1950 and only from 1950–1999, are compared to test whether potential losses are mostly from the extreme south of the province. Finally, significant records from after 2000 are considered.

This analysis is possible because of the efforts of many generalist insect collectors, epitomized and encouraged by D. H. Pengelly. Beetles were not his focus, yet while pursuing bees, many beetles ended up on pins. For each of more than 30 consecutive years starting

in the mid-1950s, there are cerambycids collected by Pengelly in the University of Guelph collection. These are of inestimable value in documenting faunal change. Perhaps more important are the hundreds of specimens collected by dozens of young students motivated by Pengelly to learn about where insects live and what they do. From the 1960s to the 1980s students in his insect collection course collected beetles across southern Ontario. These students, including several contributors to this volume, are prominent on labels of cerambycids. The specimens deposited in the University of Guelph collection, are more important than numbers alone indicate, because at the same time relatively few cerambycids were being deposited in the other major collections in Ontario. D. H. Pengelly's genuine curiosity about insects and his ability to ignite curiosity in others made this contribution possible.

Methods

We identified all pinned adult specimens of Cerambycidae collected in Ontario (N=18,469) in five major insect collections: Canadian National Insect Collection, Ottawa, ON [CNC, n=6,050 specimens]; Royal Ontario Museum, Toronto, ON [ROME, n=4,517]; University of Guelph, Guelph, ON [DEBU, n=4,511]; Great Lakes Forestry Centre, Sault Ste. Marie [GLFR, n=2,142]; Canadian Museum of Nature, Aylmer, PQ [CMNC, n=705]; and in collections with smaller holdings: Lyman Entomological Museum, McGill University, Montreal, PQ [LEMQ, n=397]; Canadian Forestry Service-Fredericton, NB [FRLC, n=80]; Algonquin Provincial Park Visitors Centre, ON [APVC, n=67]; and the Nova Scotia Museum of Natural History, Halifax, NS [NSMC, n=1].

The primary source for identifications and taxonomy was Yanega (1996), supplemented with Linsley (1962a; 1962b; 1963; 1964), Linsley and Chemsak (1972; 1976; 1985; 1995), Chemsak (1996), and a few recent revisions to nomenclature (e.g. Napp 1994). McNamara (1991) provided a checklist of species in Ontario. Non-native species collected in Ontario but presumed not to be established, such as *Physocnemum andreae* (Laplante 1989; McCorquodale 2002), *Phymatodes lividus*, and *Prionus californicus* (Fletcher 1907), are not included.

Label data were recorded for all specimens collected up to and including 1999. All specimens from the same location in one year were considered one record. Specimens from a more specific locality and a less specific locality in the same year were counted as one record (i.e. Ottawa in 1905 and Eastern Ontario in 1905 counted as one record). Selected specimens collected since 2000 and deposited in the University of Guelph collection are included separately and are not considered in the main analysis.

Old specimens with no year indicated on the label made up a substantial proportion of all specimens (McCorquodale 2002) and were combined in the category 'Limited Data' and then with all specimens from the 1860s to 1919 in the category 'Before 1920'. The importance and the limitations of these data were explained in McCorquodale (2002). These specimens represent the fauna of Ontario prior to 1920, despite having incomplete label information.

From the specimen label data, we tallied the number of records before 1950, from 1950–1999, and in eight 'decade' categories (before 1920, 1920s, 1930s, 1940s, 1950s,

1960s, 1970s, 1980s+1990s), four before 1950 and four from 1950–1999. These latter categories are referred to as 'decades'. Some analyses compare pre-1950 and 1950–1999 records, two categories with an approximately equal number of records (Fig. 1; 3,902 and 4,160). Others compare the eight 'decades', again each having a similar number of records (range 855 to 1,284). The biased sample of specimens from after 2000 is only considered separately.

Individual-based rarefaction, using records as defined above, was used to calculate expected species richness for each of the time categories (before 1950 and 1950–1999 and decade) to test whether species richness changed. Rarefaction iteratively sub-samples a data set to produce a taxon-sampling curve that represents the expected number of species for a given sample size (Krebs 1999; Buddle et al. 2005; Gotelli and Entsminger 2005). This allows comparisons between data sets with different sample sizes by comparing expected species richness for a common number of individuals (i.e. the sample size is set slightly smaller than the smallest sample). Expected species richness was compared at 3,800 records for before 1950 compared to 1950 to 1999 and at 800 records for the eight 'decades'. Estimates of the expected species richness, variance and 95% confidence intervals were based on 1,000 iterations using EcoSim 7.72 (Gottelli and Entsminger 2005).

Results

Completeness of inventory. Two hundred species, approximately 95% of the 211 species of Cerambycidae now known from Ontario, had been collected before 1950 (Table 1). The many old specimens collected prior to 1920, some with incomplete label data, included 179 species; the next highest 'decade' total is 157 species from the 1930s (Fig. 1). The 1930s also had the fewest records. The asymptotic nature of the species accumulation curve (Fig. 2) suggests the inventory of Cerambycidae of Ontario is relatively complete. Between 1950 and 1999 one species was added to the fauna about every 5 years.

We here add the following species not recorded in Ontario by McNamara (1991) or McCorquodale (2002).

Cerambycinae, Clytini, *Xylotrechus mormonus* (LeConte): Ontario, Deux-Rivieres, 26 July 1956, F[orest] I[nsect] S[urvey], CNC.

Lamiinae, Ataxiini, *Ataxia brunnea* Champlain and Knull. Ontario, Chatham Lab, Summer 1937, CNC; Ontario, Harrow, 1 July 1961, R. S. Dickout, DEBU.

Comparison of species richness before 1950 and 1950 to 1999. Fewer species of Cerambycidae were collected between 1950 and 1999 than prior to 1950. Raw species richness prior to 1950 was 200, compared to 191 for 1950–1999. However, it is more appropriate to compare species richness with rarefaction estimates that control for unequal sample size. The rarefied expected species richness prior to 1950, 199.5 (198–200, 95% CI), was higher than for the period 1950–1999, 188.3 (186–190, 95% CI). Comparison of rarefaction estimates for the eight 'decades' (Fig. 3) demonstrates the decline in species richness for collections from 1950 to 1999 compared to prior to 1950. All four pre-1950 'decades' had higher species richness than all four 1950 to 1999 'decades'.

TABLE 1. The number of records by decade based on 18,469 specimens of Cerambycidae collected in Ontario. For analyses of 'decades' Limited data, 1800s, 1900s, and 1910s were combined in Before 1920 and 1980s and 1990s were also combined.

	Limited Data	1800s	1900s	1910s	1920s	1930s	1940s	1950s	1960s	1970s	1980s	1990s	Total
Aseminae													
Asemini													
Arhopalus foveicollis (Haldeman)	7	4	2	4	11	14	8	9	9	5			73
Arhopalus rusticus obsoletus (Randall)						1							1
Asemum striatum (Linnaeus)	9	2	2	3	11	13	12	16	22	12	6	3	111
Tetropium cinnamopterum Kirby	3	1		1	2		5	2	2	3	3		22
Tetropium parvulum Casey				2	3		1	1					7
Tetropium schwarzianum Casey	1	1					2			3			7
Atimiini													
Atimia confusa confusa (Say)	1				1	3		1	2	2	1	2	13
Cerambycinae													
Anaglyptini													
Cyrtophorus verrucosus (Olivier)	6	1	3	2	11	13	16	16	16	21	16	7	128
Microclytus compressicollis (Laporte and Gory)	2			3		1	3						9
Bothriospilini													
Knulliana cincta cincta (Drury)	3	1		1		2		1	2	5	2		17
Callidiini													
Callidium antennatum Newman	1												1
Callidium frigidum Casey	3	2		2	5	4	2	2	7	5	4		36
Callidium violaceum (Linnaeus)	4		2	5	5	1	3	2	2	2	3		29
Meriellum proteus (Kirby)	4	1	1		10	4		1		2		1	24
Phymatodes aereus (Newman)	2				3				1	1			7
Phymatodes amoenus (Say)	1		1		7	4	11	1	5	6	4	2	42
Phymatodes dimidiatus (Kirby)	4		1	3	11	2	1	1	1		1		25

TABLE 1. Continued.

	Limited Data	1800s	1900s	1910s	1920s	1930s	1940s	1950s	1960s	1970s	1980s	1990s	Total
Callidiini continued													
Phymatodes maculicollis LeConte											1		1
Phymatodes testaceus (Linnaeus)	3				2	1	2	3	4	4	9	1	29
Phymatodes varius (Fabricius)	1					1	1	1					4
Physocnemum brevilineum (Say)	5		2	4	5	6	11	7	5	7			52
Pronocera collaris (Kirby)		1			7		2	6	4	1	1	1	23
Ropalopus sanguinicollis (Horn)	1				2	2	1	2	1		1		10
Semanotus ligneus (Fabricius)	5	3	2	2	1	4	4	1	4	1	1	2	30
Semanotus litigiosus (Casey)	1		1	2	1				3		1		9
Clytini													
Calloides nobilis (Harris)	3	5	2	1	1	1	2	1					16
Clytoleptus albofasciatus (Laporte and Gory)								1	1	1			3
Clytus marginicollis Laporte and Gory										2			2
Clytus ruricola (Olivier)	8	8	7	14	26	19	21	27	40	39	31	27	267
Glycobius speciosus (Say)	6	2			4	2	5	3	1	3	2		28
Megacyllene caryae (Gahan)	2	1	2		1					2			8
Megacyllene robiniae (Forster)	7	9	8	6	13	12	9	16	10	19	12	14	135
Neoclytus acuminatus (Fabricius)	3			4	13	20	15	11	10	17	8	4	105
Neoclytus caprea (Say)	1						1						2
Neoclytus leucozonus (Laporte and Gory)	4		4	4	7	5	1	11	2	2	2		42
Neoclytus mucronatus (Fabricius)	2			1		2	1						6
Sarosesthes fulminans (Fabricius)	4	1		1	4	1	1		1	3	3	5	24
Xylotrechus aceris Fisher	2				1	1	2	2	1	1			10
Xylotrechus annosus (Say)	2				4	2	1	7	11	5	2	1	35
Xylotrechus colonus (Fabricius)	6	1	2	2	8	15	4	6	10	12	13	6	85

TABLE 1. Continued.

	Limited Data	1800s	1900s	1910s	1920s	1930s	1940s	1950s	1960s	1970s	1980s	1990s	Total
Clytini continued													
Xylotrechus convergens LeConte	1								1		1		3
Xylotrechus mormonus (LeConte)								1					1
Xylotrechus quadrimaculatus (Haldeman)	2			1	1			2				2	8
Xylotrechus sagittatus (Germar)	4	3		2	1	2	3	5	3	2		2	27
Xylotrechus undulatus (Say)	9	7	1	3	15	2	13	16	20	5	4	5	100
Elaphidiini													
Anelaphus parallelus (Newman)	2			1	4	8		15	5	9	4	5	53
Anelaphus pumilus (Newman)									1	1			2
Anelaphus villosus (Fabricius)	2	1		2	6	8	3	1	5	4		3	35
Elaphidion mucronatum (Say)	1					6			2	3	2	1	15
Enaphalodes atomarius (Drury)	1										1		2
Enaphalodes cortiphagus (Craighead)	1				1	2			1	1			6
Enaphalodes rufulus (Haldeman)	3	3	2	2	7	7	2	2	8	3		6	45
Parelaphidion aspersum (Haldeman)	4	1				3			1	2	1		12
Psyrassa unicolor (Randall)	2		1	1	2	3	2	1	4	5	1	1	23
Stenosphenus notatus (Olivier)	1						1						2
Hesperophanini													
Eburia quadrigeminata (Say)	2				1	5	1		1			1	11
Hesperophanes pubescens (Haldeman)	1				2	1			3	1	1	2	11
Tylonotus bimaculatus Haldeman	3	1	3	5		1	4	5	5	2	2	1	32
Ibidionini													
Heterachthes quadrimaculatus Haldeman	1			1	2	1		4	1				10
Molorchini													
Molorchus bimaculatus Say	5	1	4		7	13	3	10	7	3	14	4	71

TABLE 1. Continued.

	Limited Data	1800s	1900s	1910s	1920s	1930s	1940s	1950s	1960s	1970s	1980s	1990s	Total
Obriini													
Obrium maculatum (Olivier)	1												1
Obrium rufulum Gahan	2		1		6	7	7	3	6	3	2	1	38
Smodicini													
Smodicum cucujiforme (Say)									1	2			3
Stenopterini													
Callimoxys sanguinicollis (Olivier)	3		2	1	7	6	6	5	2	5	4		41
Tillomorphini													
Euderces picipes (Fabricius)	4	4	4	1	6	14	7	4	12	16	5	7	84
Trachyderini													
Batyle suturalis (Say)	1	3	2	1	1	4	3			1	1	6	23
Purpuricenus humeralis (Fabricius)	2				2		4	3	1	2			14
Lamiinae													
Acanthocinini													
Acanthocinus obsoletus (Olivier)	2	1				2			1				6
Acanthocinus pusillus Kirby	5	3	1	5	3	7	9	9	7	6	1	1	57
Astylopsis collaris (Haldeman)					1	1						2	4
Astylopsis macula (Say)	5			2	15	3	5	7	2	2	1	1	43
Astylopsis sexguttata (Say)	3			1	7	7	8	4	5	3	2	1	41
Dectes sayi Dillon and Dillon						2	1				1	2	6
Hyperplatys aspersa (Say)	5	3		2	10	12	12	12	12	17	15	3	103
Hyperplatys maculata Haldeman	4		1	4	13	7	3	10	6	5	1		54
Leptostylus transversus (Gyllenhal)	2			1	2	2	1	3	1				12
Lepturges confluens (Haldeman)	1				3	1	1				1		7
Lepturges symmetricus (Haldeman)	2			1	6	1	3	3	2	2	2		22

TABLE 1. Continued.

	Limited Data	1800s	1900s	1910s	1920s	1930s	1940s	1950s	1960s	1970s	1980s	1990s	Total
Acanthocinini continued.													
Liopinus alpha (Say)	3		2	5	11	14	13	10	10	4	5	1	78
Sternidius variegatus (Haldeman)	2		2	1	2	4	8	1	4	10	1		35
Urgleptes facetus (Say)	1					1		1		1		1	5
Urgleptes querci (Fitch)	2			2	7	5	13	7	7	7	6	1	57
Urgleptes signatus (LeConte)	1		1	2	8	2	4	6	1	1	3	1	30
Urographis despectus (LeConte)	2	1			1	3	1	1					9
Urographis fasciatus (DeGeer)	5	2	2	2	11	4	3	2	6	4	10	6	57
Acanthoderini													
Aegomorphus modestus (Gyllenhal)	3		1	4	7	2	1	2	3	6	3		32
Aegomorphus quadrigibbus (Say)	1												1
Oplosia nubila (LeConte)	2			3	9	3	3		6		1		27
Apodasyini													
Eupogonius pauper LeConte	1		1	2	3	3	3	2	2	2	2		21
Eupogonius subarmatus (LeConte)	2				7	6	5	7	3	1	2	1	34
Eupogonius tomentosus (Haldeman)	2			1	1		1	1				1	7
Psenocerus supernotatus (Say)	4		3	3	9	10	13	9	17	23	13	2	106
Ataxiini													
Ataxia brunnea Champlain and Knull						1			1				2
Cyrtinini													
Cyrtinus pygmaeus (Haldeman)	1												1
Dorcaschematini													
Dorcaschema alternatum (Say)	1												1
Dorcaschema cinereum (Olivier)			1				1			1			3
Dorcaschema nigrum (Say)	3		1	2	2	11	4	1	1				25

TABLE 1. Continued.

	Limited Data	1800s	1900s	1910s	1920s	1930s	1940s	1950s	1960s	1970s	1980s	1990s	Total
Hippopsini													
Hippopsis lemniscata (Fabricius)						1	1			2	4		8
Lamiini													
Goes debilis LeConte	5	2	1		2	1	1	1	2	1	1	1	18
Goes pulcher (Haldeman)	3	1	1			3	1						9
Goes pulverulentus (Haldeman)	2			1		1	2	2	1	1			10
Goes tigrinus (DeGeer)	1												1
Hebestola nebulosa Haldeman					1				1	1			3
Microgoes oculatus (LeConte)	3	1	1	1	8	3	3	5	6	1	3	1	36
Monochamus carolinensis (Olivier)	2	1	2	2	3	2	4		2	1	1	2	22
Monochamus marmorator Kirby			1	2	6	2	9	3	8		1		32
Monochamus mutator LeConte	1	1			1	1	2	13	5	1	3	1	29
Monochamus notatus (Drury)	8	7	7	9	16	12	28	17	22	18	8	12	164
Monochamus scutellatus (Say)	8	2	8	6	18	23	23	18	24	55	45	30	260
Monochamus titillator (Fabricius)				1	1							1	3
Onciderini													
Oncideres cingulata (Say)	2												2
Phytoecini													
Oberea affinis Leng and Hamilton	4	1	4	3	9	9	14	6	5	20	3	2	80
Oberea caseyi Plavilstshikov	2				2	1		2					7
Oberea deficiens Casey					1		1	1	1	1		1	6
Oberea delongi Knull					2		5	1		2			10
Oberea erythrocephala (Fabricius)										1	1		2
Oberea ocellata Haldeman							1				2		3
Oberea oculaticollis (Say)							1						1

TABLE 1. Continued.

	Limited Data	1800s	1900s	1910s	1920s	1930s	1940s	1950s	1960s	1970s	1980s	1990s	Total
Phytoecini continued.													
Oberea pallida Casey						1	1	1		1	1		5
Oberea perspicillata Haldeman	4		1	1	2	4	5	3	3	8	3	2	36
Oberea praelonga Casey	1		1	2	6	5	11	11	3	9	6	1	56
Oberea pruinosa Casey						1	2		2				5
Oberea schaumii LeConte					1	3	3	2	1	2	1		13
Oberea tripunctata (Swederus)	1			2	8	26	17	24	21	38	19	7	163
Pogonocherini													
Ecyrus dasycerus dasycerus (Say)	2					2	6	2		6		1	19
Pogonocherus mixtus Haldeman	3	3	1	2	10	5	2	9	2	3			40
Pogonocherus parvulus LeConte					1	2	4		1	3			11
Pogonocherus penicillatus LeConte	2		2		1	4	3	8	4	1			25
Saperdini													
Saperda calcarata Say	7	3	4	4	2	9	9	11	18	11	4	3	85
Saperda candida Fabricius	4	3		1	1	3	4	10	4	4	3	6	43
Saperda cretata Newman	1				3	2						1	7
Saperda discoidea Fabricius	1				3	3	1	2	1			1	12
Saperda fayi Bland	3				2	7	3	2	2	1			20
Saperda imitans Felt and Joutel	1				2	2		3		2		3	13
Saperda inornata Say	2	3	2	3	2	3	11	9	7	2	3	1	48
Saperda lateralis Fabricius	3			2	7	5	8	3	2	2	4	1	37
Saperda mutica Say	1		1	1	3	2	7	3	2	5			25
Saperda obliqua Say				2	1	3	1	3	9	2	1	1	23
Saperda populnea moesta LeConte	1	4		1	4	7	8	8	3	7	4		47
Saperda puncticollis Say	2	1	2	2	1	9	7	8	1	4	5	3	45

TABLE 1. Continued.

	Limited Data	1800s	1900s	1910s	1920s	1930s	1940s	1950s	1960s	1970s	1980s	1990s	Total
Saperdini continued.													
Saperda tridentata Olivier	8	3		3	15	16	18	21	42	40	13	2	181
Saperda vestita Say	7	4	1	4	16	19	10	9	10	9	4		93
Tetraopini													
Tetraopes femoratus LeConte					1		1	1					3
Tetraopes melanurus Schonherr	1		1		1						1		4
Tetraopes quinquemaculatus Haldeman	1						1					3	5
Tetraopes tetrophthalmus (Forster)	7	8	11	5	17	18	13	31	34	73	59	20	296
Lepturinae													
Desmocerini													
Desmocerus palliatus (Forster)	6	1		3	4	8	12	10	13	7	8	2	74
Lepturini													
Acmaeops pratensis (Laicharting)	6	2	3	2	5	6	3	3	6	2	4		42
Acmaeops proteus (Kirby)	6	1	1	4	10	7	9	15	19	10	5	2	89
Acmaeopsoides rufula (Haldeman)								2	4		3		9
Analeptura lineola (Say)	6		2	4	10	8	9	6	11	22	19	11	108
Anastrangalia sanguinea (LeConte)	1				4		1		3		4		13
Anoplodera pubera (Say)	6	6	3	3	10	13	9	14	19	21	18	4	126
Anthophylax attenuatus (Haldeman)	2				1	2	5	1	5	3	6	3	28
Anthophylax cyaneus (Haldeman)	2		1	1	2	3	2	3	6	1	4	4	29
Anthophylax viridis LeConte									2		1		3
Bellamira scalaris (Say)	4	1		2	8	4	6	7	9	4	9	3	57
Brachyleptura champlaini Casey	3	5		3	2	2	1	1	3	4	2	5	31
Brachyleptura rubrica (Say)	2		1		5	3	4	1	1	4	3	1	25
Brachysomida bivittata (Say)	1												1

TABLE 1. Continued.

	Limited Data	1800s	1900s	1910s	1920s	1930s	1940s	1950s	1960s	1970s	1980s	1990s	Total
Lepturini continued.													
Centrodera decolorata (Harris)	5	3		4	3	1	3	2	6	1		1	29
Charisalia americana (Haldeman)					2		1				1		4
Encyclops caerulea (Say)	6	1	4	1	2	2	2	1	1				20
Evodinus monticola (Randall)	2	1	4	1	9	3	11	16	9	8	4	9	77
Gaurotes cyanipennis (Say)	4	6	1	1	11	14	10	9	6	7	4	6	79
Grammoptera exigua (Newman)	2		2		5	1	4	1	1	1	1		18
Grammoptera haematites (Newman)	4		1		6	4	8	7	1	2	3		36
Grammoptera subargentata (Kirby)	1	1	2	1	5	7	2	7	10	9	7	2	54
Idiopidonia pedalis (LeConte)				1					3	1		2	7
Judolia montivagans (Couper)	4	3			3	1	4	5	7	7	11	3	48
Judolia quadrata (LeConte)					2	1		1					4
Leptura emarginata Fabricius	1					2			1	4		1	9
Leptura plebeja Randall	2	4		3		2			4		2	3	20
Leptura subhamata Randall	5	7	3	3	6	9	5	6	4	6	3	1	58
Lepturobosca chrysocoma (Kirby)	4	3	1	2	10	6	5	12	20	18	14	3	98
Lepturopsis biforis (Newman)	3	4	2	1	9	6	7	8	5	7	5	6	63
Neoalosterna capitata (Newman)	3		2	2	5	3	7	1	3		5	1	32
Pachyta lamed Kirby	2				2	1		2			1		8
Pidonia ruficollis (Say)	6	1	3	3	10	6	9	3	8	16	21	5	91
Pseudogaurotina abdominalis (Bland)	1	2				2	2	2	2	3	1	2	17
Pseudostrangalia cruentata (Haldeman)							1		1				2
Pygoleptura nigrella (Say)	4	1			7	2	2	2	6	1	2		27
Rhagium inquisitor (Linnaeus)	5	3	3	1	6	5	6	12	5	7	8		61
Sachalinobia rugipennis (Newman)			1	1	1	1	5	3	3	1	1	1	18

TABLE 1. Continued.

	Limited Data	1800s	1900s	1910s	1920s	1930s	1940s	1950s	1960s	1970s	1980s	1990s	Total
Lepturini Continued.													
Stenocorus schaumii (LeConte)	1		2	3	3	3	3		2	1	1		19
Stenocorus vittiger (Randall)	6	2	1		6	1	8	1			1		26
Stictoleptura canadensis (Olivier)	9	8	8	5	21	16	12	22	17	12	12	10	152
Strangalepta abbreviata (Germar)	7	8	7	7	22	28	11	14	17	36	19	14	190
Strangalia acuminata (Olivier)	1						1						2
Strangalia bicolor (Swederus)						1							1
Strangalia luteicornis (Fabricius)	2				3	4	6			3	4		22
Strophiona nitens (Forster)	5	4		2	4	6	5		1	1	5	5	38
Trachysida aspera brevifrons (Howden)		1		1	1			3	3	2	2	1	14
Trachysida mutabilis (Newman)	5	3	2	1	20	10	10	18	21	19	21	10	140
Trigonarthris minnesotana (Casey)	1	5		1	18	2	8	12	22	11	15	9	104
Trigonarthris proxima (Say)	7	12	2	6	10	10	15	9	16	10	7	9	113
Typocerus acuticauda Casey	1			1	3		3	1		2	1		12
Typocerus lugubris (Say)	3		2	1									6
Typocerus octonotatus (Haldeman)							1						1
Typocerus sparsus LeConte	3	2	2	2	5	7	10	7	18	15	5	4	80
Typocerus velutinus (Olivier)	6	7	5	8	16	24	19	30	28	48	13	15	219
Xestoleptura octonotata (Say)	4				1	1					1	2	9
Xestoleptura tibialis (LeConte)					3			3	2	2		3	13
Necydalini													
Necydalis mellita (Say)	2				1	2						1	6
Parandrinae													
Parandrini													
Neandra brunnea (Fabricius)	7	5	8	4	16	13	9	7	22	32	12	6	141

TABLE 1. Continued.

	Limited Data	1800s	1900s	1910s	1920s	1930s	1940s	1950s	1960s	1970s	1980s	1990s	Total
Prioninae													
Meroscelisini													
Tragosoma depsarium (Linnaeus)	5	4	6		1	1	1	6	7	3		1	35
Prionini													
Orthosoma brunneum (Forster)	3	5	4	2	13	6	9	12	12	11	7	4	88
Prionus laticollis (Drury)	1												1
Prionus pocularis Dalman	3				1	2			2	1	1	1	11
Spondylidinae													
Spondylidini													
Neospondylis upiformis (Mannerheim)									1				1
TOTAL	**535**	**248**	**219**	**282**	**902**	**855**	**861**	**894**	**1010**	**1075**	**750**	**430**	**8062**

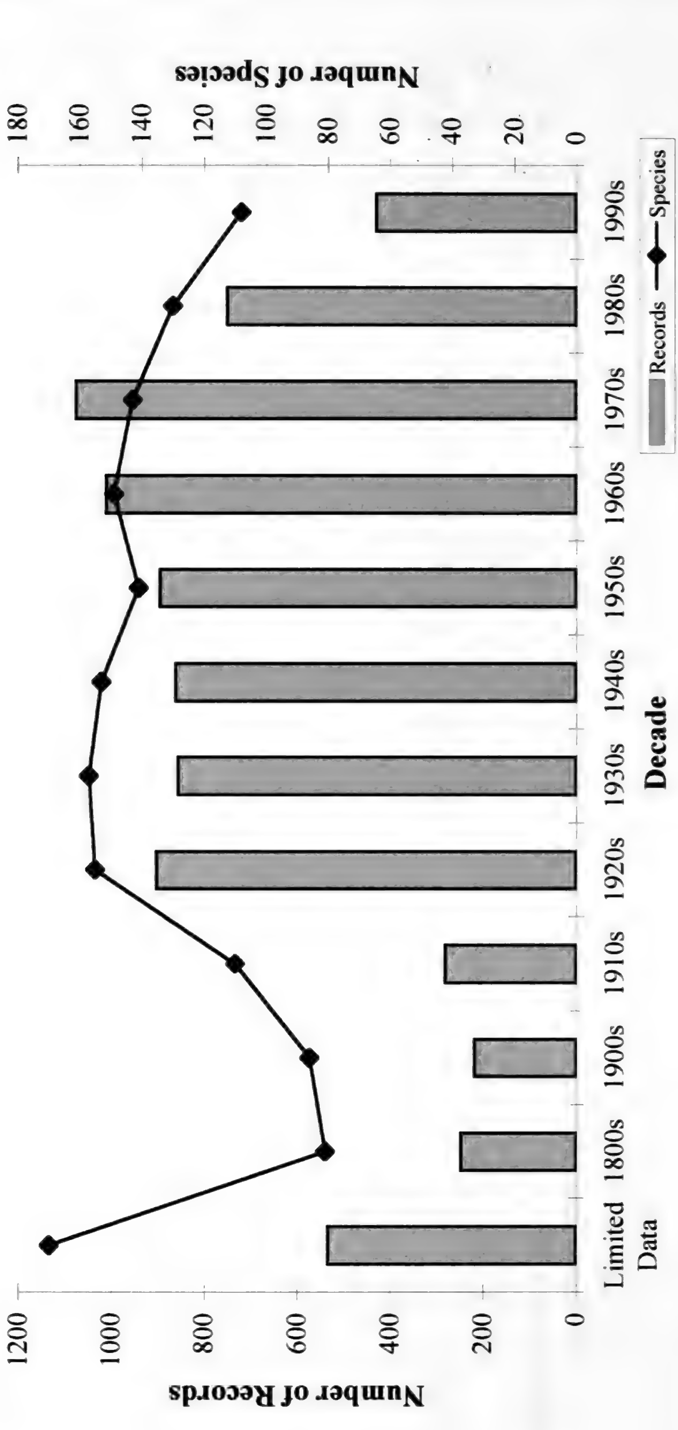

FIGURE 1. Temporal distribution of records (1/location/year) for the 18,469 specimens of Cerambycidae from Ontario. The 'Limited Data' are combined with those from the 1800s, 1900s and 1910s as Before 1920, and those from 1980s and 1990s as 1980–1989 for some analyses.

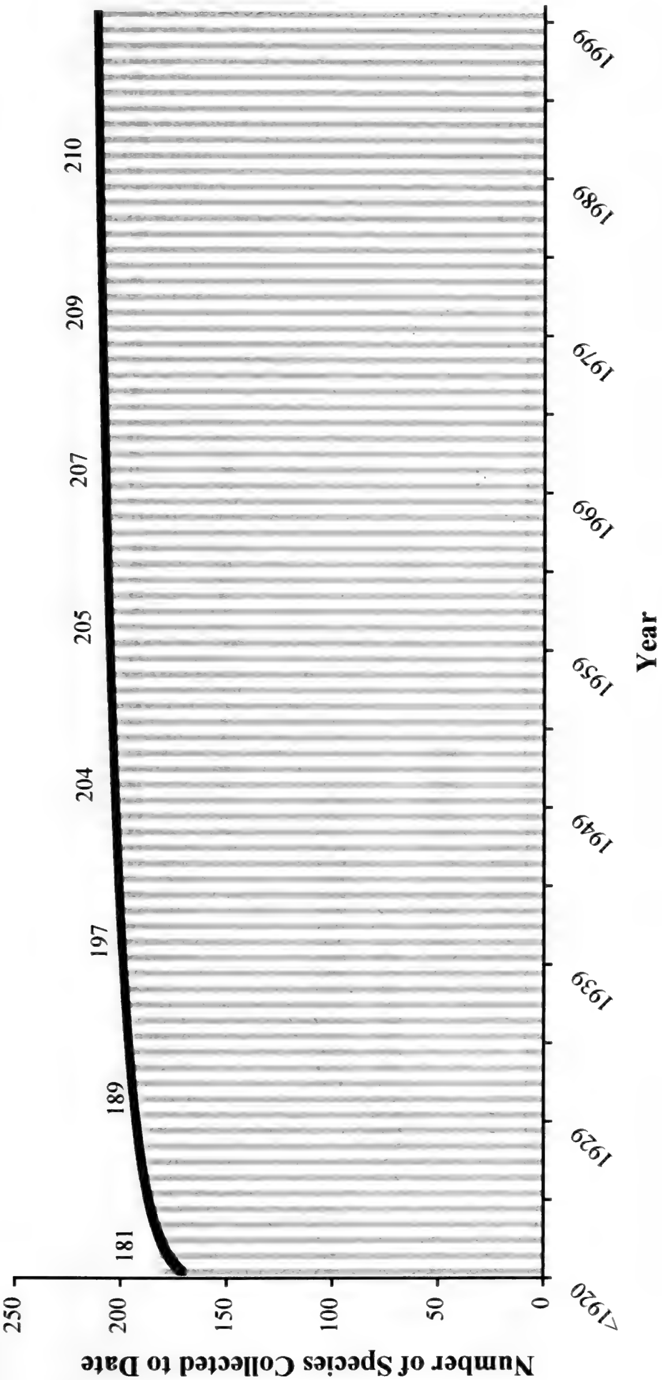

FIGURE 2. Species accumulation curve for Ontario Cerambycidae. The first category represents all cerambycids with limited data on the labels, that is collected prior to 1920.

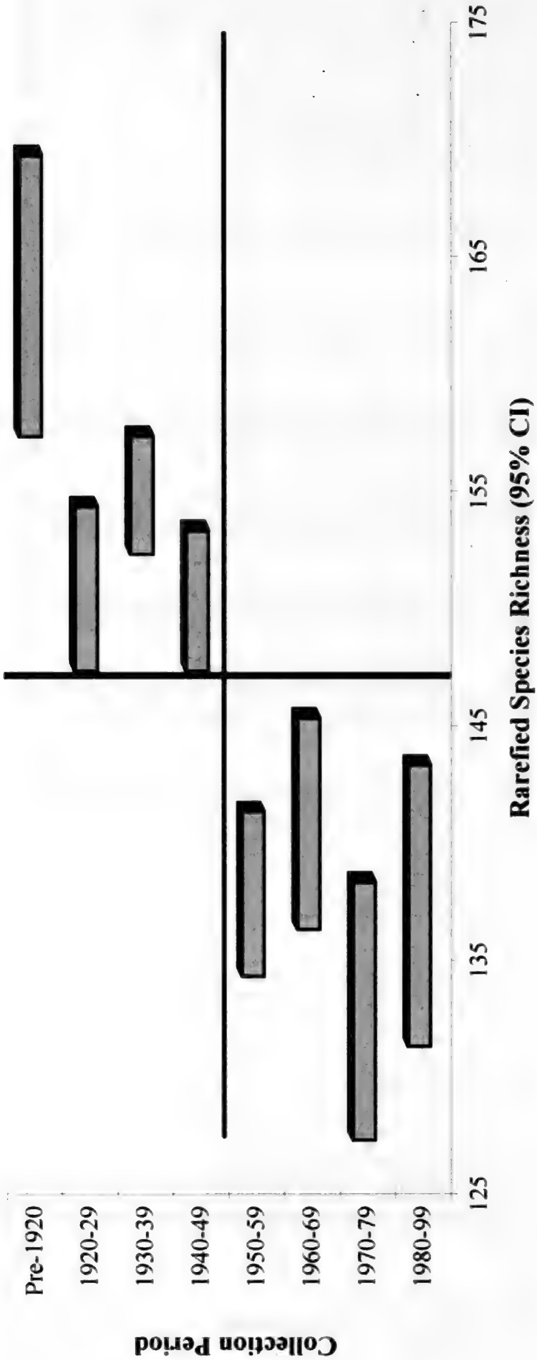

FIGURE 3. Rarefied species richness for Ontario cerambycids for eight 'decades'. The vertical line shows that the 95% confidence intervals of the four 'decades' from before 1950 do not intersect with the 95 % confidence intervals of the four 'decades' from after 1950–1999. Estimates are based on a sub-sample of 800 records and 1,000 iterations using EcoSim (Gotelli and Entsminger 2005).

Species only in collections from prior to 1950 or 1950 to 1999. Twenty species were collected prior to 1950, but not between 1950 and 1999 (Table 2). Nine species not collected before 1950 are first represented in collections by specimens collected between 1950 and 1999 (Table 3).

Most species collected only before 1950 or only between 1950 and 1999 were from southern Ontario, that is south of the Canadian Shield (Tables 2, 3). Locality information on labels from 100 years ago is often imprecise. However, most of these species were collected in extreme southern Ontario, along the Lake Ontario shore, Lake Erie shore, or in southwestern Ontario. Of the 28 species in these two categories, only two were collected in central and northern Ontario, with one, *Microclytus compressicollis*, also collected further south.

Many of the species only collected prior to 1950 use hardwoods as larval hosts (Table 2). The relatively few, 3 of the 20, that use conifers are associated with pines. The nine species collected only between 1950 and 1999 included three that use conifers as hosts.

Four significant records since 2000. Since 2000, three species have been detected in Ontario for the first time:

Disteniinae, Disteniini, *Distenia undata* (Fabricius). Ontario, Essex, 10 km E of Essex, 1 August 2000, R. Marchese, Det. BD Gill 2003, CNC. Ontario, Pelee Island, Porchuk property malaise trap 17-22 July and 28 August–10 September 2001, S. A. Marshall and B. Porchuk, DEBU.

Lamiinae, Lamiini, *Anoplophora glabripennis* (Moltschulsky). First identified in Canada on the basis of specimens brought to University of Guelph from packing crates shipped to an industry in Waterloo, Ontario in June of 1998, but not detected outdoors in Canada until 2003 (in northwest Toronto and Vaughan). The Canadian Food Inspection Agency (2005) reports on ongoing attempts to eradicate and maps occurrences up until September 2005.

Lamiinae, Tetraopini, *Tetrops praeusta* (Linnaeus). ONT: Halton (Reg.), Milton, Woodland Trails Cape, 6th Line Nassagewaya, meadow, yellow pans, 5-6 June 2001, S. Paiero, DEBU 00172650 and 00172655. ONT. Wellington Co., Guelph, meadow, 6 June 2002, O. Lonsdale, DEBU00185522.

One species that was not collected between 1950 and 1999 was found after 2000. Cerambycinae, Anaglyptini, *Microclytus compressicollis* (Laporte and Gory). ON Cornwall, 14 May 2003, Old-growth forest F[light] I[ntercept] T[rap]-20, 45° 02.160' N, 74° 47.470' W, OG2-COR, R. Zeran, LEMQ.

Discussion

Do we know the Ontario cerambycid fauna? The Cerambycidae in Ontario are well known, in contrast to many insect taxa. Three pieces of evidence support this assertion. About 95% of the species were collected prior to 1950, the species accumulation curve approaches an

TABLE 2. Number of specimens and records of the 20 species of Cerambycidae collected prior to 1950 but not between 1950 and 1999 in Ontario. Locations are from label data and hosts are from Linsley and Chemsak (1997) and Yanega (1996).

Species	Specimens	Records	Locations	Hosts	Collections
Arhopalus rusticus obsoletus (Randall)	5	1	Grand Bend	Pine	CNC
Microclytus compressicollis (Laporte and Gory)	20	9	Thunder Bay, Peterborough, Ottawa, Kitchener, Hamilton	?	CNC, GLFR, ROME, DEBU
Callidium antennatum Newman	1	1	Ridgeway	Pine, Spruce	DEBU
Neoclytus caprea (Say)	2	2	St. Catharines, London	Hickory, Hackberry, Ash, Walnut, Other hardwoods	CNC, DEBU
Neoclytus mucronatus (Fabricius)	11	6	Harrow, Grimsby, Jordan, St. Davids, Ridgeway	Hackberry	CNC, LEMQ, ROME, DEBU
Stenosphenus notatus (Olivier)	2	2	Ridgeway, Prince Edward Co.	Hickory, Hackberry	CNC, DEBU
Obrium maculatum (Olivier)	5	1	Ridgeway	Hickory, Hackberry, Mulberry, Oak	DEBU
Aegomorphus quadrigibbus (Say)	1	1	Eastern Ontario	Maple, Birch, Hickory, Other hardwoods	CNC
Cyrtinus pygmaeus (Haldeman)	9	1	Ridgeway	Maple, Hickory, Redbud, Other hardwoods	CNC, ROME, DEBU
Dorcaschema alternatum (Say)	2	1	Ontario	Mulberry	DEBU

TABLE 2. Continued.

Species	Specimens	Records	Locations	Hosts	Collections
Goes pulcher (Haldeman)	33	9	Ridgeway, Leamington, Cobourg, London, Ottawa	Hickory, Oak, Elm	CNC, ROME, DEBU
Goes tigrinus (DeGeer)	4	3	Ridgeway	Hickory, Walnut, Oak, Elm	DEBU
Oncideres cingulata (Say)	9	2	Guelph, London	Ironwood, Hickory, Hackberry, Other hardwoods	CNC, GLFR, DEBU
Oberea oculaticollis (Say)	1	1	Ojibway	?	CNC
Brachysomida bivittata (Say)	1	1	Toronto	Hardwoods?	DEBU
Strangalia acuminata (Olivier)	3	2	Leamington, Greenwood Lake	Alder, Ironwood, Hop Hornbeam, Ninebark	CNC, DEBU
Strangalia bicolor (Swederus)	1	1	Simcoe	Maple, Oak	CNC
Typocerus lugubris (Say)	24	6	Port Hope, Ridgeway, Peterborough, London	Pine	CNC, ROME, DEBU
Typocerus octonotatus (Haldeman)	1	1	La Salle	Grasses	CNC
Prionus laticollis (Drury)	2	1	London	Hardwoods	DEBU

TABLE 3. Number of specimens and records of the 9 species of Cerambycidae collected only between 1950 and 1999 in Ontario. Locations are from label data and hosts are from Linsley and Chemsak (1997) and Yanega (1996).

Species	Specimens	Records	Locations	Hosts	Collections
Phymatodes maculicollis LeConte	1	1	Alfred	Fir	CMNC
Clytoleptus albofasciatus (Laporte and Gory)	4	3	Hamilton, Pt. Pelee, Prince Edward Co.	Grape	CNC, DEBU
Clytus marginicollis Laporte and Gory	2	2	Constance Bay, Owen Sound	Pine	CMNC, DEBU
Xylotrechus mormonus (LeConte)	1	1	Deux Rivieres	Willow	CNC
Anelaphus pumilus (Newman)	8	2	Rondeau Park	Hickory, Chestnut, Oak, Basswood, Elm	ROME
Oberea erythrocephala (Schrank)	1	2	Braeside, Windsor	Spurge	CNC, DEBU
Acmaeopsoides rufula (Haldeman)	13	9	Searchmount, Icewater Creek, Black Sturgeon Lake, Sault Ste. Marie, Kerr, Vermillion Bay, Quibell, Sudbury	Spruce?	CNC, GLFR, DEBU
Anthophylax viridis LeConte	4	3	Bruce Mines, Tenby Bay	Maple, Birch, Beech	GLFR, ROME
Neospondylis upiformis (Mannerheim)	3	1	Searchmount	Spruce, Pine	GLFR

asymptote, and with a similar collecting effort to before 1950, only 9 additional species were found in the 50 years after 1950. This has been achieved largely through efforts of general collectors. Four significant contributions by cerambycid specialists are by Brimley (1941) from Prince Edward County and environs, Gardiner (e.g. 1957; 1975) in the Sault Ste. Marie area, Hicks from Windsor and Ottawa (e.g. 1947; 1962; 1971), and E. J. Zavitz from Ridgeway in the Niagara Peninsula in the early 1900s.

Four significant records of Cerambycidae collected since 2000 demonstrate that the Ontario fauna is not static. Ranges change through both contraction and expansion, and for many species our understanding of their distributions within Ontario is rudimentary. The arrival of *Anoplophora glabripennis* in northwestern Toronto was expected (Allen and Humble 2002). Its potential to wreak havoc on suburban trees and potentially on native hardwoods in the Carolinian forest has prompted eradication efforts (Ontario Ministry of Natural Resources 2006). Another non-indigenous species, *Tetrops praeusta*, continues to expand its range in eastern North America. *Distenia undata* ranges from Ohio south to the southern Appalachians, and since 2000, it has been found twice in extreme southwestern Ontario, at Harrow and Pelee Island. In fact it is surprising that more species have not expanded their ranges north to include extreme southern Ontario. Species with a wide geographic range, hence more subpopulations, may have a better chance of surviving significant population declines. Prior to 1950 *M. compressicollis* was collected from Thunder Bay to Hamilton and Ottawa, a widespread distribution in Ontario. A specimen collected in 2003 as part of intensive sampling of saproxylic beetles in hardwood forests of eastern Ontario (Zeran et al. 2006) demonstrates it persists in Ontario. As with many other species the specimen raises more questions than it answers. Is it still widespread? What is the host plant? What are its habitat requirements? Is it endangered in Ontario?

Has the number of species in Ontario declined? Both raw species richness and rarefied estimates show about a 10% decline in the number of species collected since 1950. A contributing factor is the 20 species not collected between 1950 and 1999. In addition, 23 species were minimally represented between 1950 and 1999, 20 with only one record and another three collected in only one decade. Only 9 species were first recorded between 1950 and 1999, a net loss of 11 species. The date 1950 is not of special significance, but merely a convenient split to produce two samples with similar collecting effort. Using 1940 or 1960 as the break results in similar patterns. The general trend for lower species richness per decade (Fig. 3) supports this assertion.

The decline in number of species of cerambycids in Ontario may have been driven by environmental change; for cerambycids the most likely changes are in the abundance and distribution of host plants and their habitats. Alternatively, the apparent decline may be a function of collecting biases.

Forest regions: The cerambycids collected only prior to 1950 were concentrated in the southern part of the province, primarily the Carolinian Forest Region. Most of Ontario is boreal forest (dominated by coniferous trees) and Great Lakes-St Lawrence mixed forest (Rowe 1972; Hosie 1990; Armson 2001). Only one species from the boreal forest in northern Ontario, *Microclytus compressicollis*, was not collected 1950–1999; it was also collected further south. In contrast, many species from the Carolinian or deciduous forest region

of extreme southern Ontario were not collected from 1950 to 1999. This forest region occupies a limited area along the north shore of Lake Ontario, west to Pinery Provincial Park on Lake Huron and all areas to the south, including the Niagara Peninsula and the north shore of Lake Erie (Rowe 1972; Larson et al. 1999). Despite the limited geographic area, at least 16 of the 20 species collected only prior to 1950 are known only from this area. In contrast only two of the nine species collected only between 1950 and 1999 were restricted to the Carolinian forest region.

Clearing land for farms, towns and cities, and for timber extraction removed most of southern Ontario's original forest cover before 1900 (Armson 2001). Reduction of forest area is most pronounced in the Carolinian because of intensive agriculture and the concentrations of urban centres (Austen et al. 1994; Larson et al. 1999; Armson 2001). Significant forest loss from the small overall area of Carolinian forest in Ontario has contributed to the reduction in its unique cerambycid fauna and consequently to the Ontario fauna as a whole.

Host plants: The distribution of each cerambycid species depends on the range of appropriate host plants. Southern hardwoods, such as hickory and hackberry, are the host plants of half of the 20 species collected only before 1950. Given the decline of Carolinian forests, it is not surprising many of these apparently declining species use southern hardwoods as hosts. Of the 9 species collected only between 1950 and 1999, only *Anelaphus pumilus* uses southern hardwoods (hickories) as hosts.

The lack of collections after 1950 of three species that feed on pine was not expected, because White Pine, *Pinus strobus* L., is still a reasonably common and widespread tree, even if there are fewer really old trees now. In addition, Red Pine, *P. resinosa* Soland and Jack Pine, *P. banksiana* Lamb, are now more common in southern Ontario in plantations, especially on abandoned farms on poor sandy soils.

Are the species not collected between 1950 and 1999 extirpated? Our understanding of current distributions of cerambycids is based on specimens in insect collections, as are the compilations of Linsley and Chemsak (e.g. 1985; 1995), McNamara (1991) and McCorquodale (2002). Unlike the recent atlas of bird distributions in Ontario (Cadman et al. 1987), we have no broad, recent, focused, geographical surveys of cerambycids. Though we do have a reasonable inventory, and an apparent decline in the number of species, we do not have sufficient information to assert that the lack of specimens of a particular species in post-1950 collections represents a significant population decline or an extirpation.

At first glance the decline in the number of species does not appear to be the result of a lack of collecting because there are more specimens and records from 1950–1999 than prior to 1950. It seems unlikely that the ability of collectors has declined since 1950, and certainly our understanding of natural history and host plant use has increased. General collecting has revealed new records for Ontario, for example *Anelaphus pumilus*, *Clytoleptus albofasicatus*, *Anthophylax viridis*, and *Clytus marginicollis*. All were part of general insect collecting rather than focused collecting for cerambycids.

However, since 1950 there has been limited collecting in southern Ontario by cerambycid specialists and this may have reduced the number of species collected. The hard to collect specimens may have been missed because specialized knowledge and collecting

techniques were lacking. In southern Québec, where similar changes in forest cover have occurred, there has been not been a similar decline in species richness in collections of cerambycids. The main reason is a cadre of keen amateur coleopterists with specialized knowledge of cerambycid natural history (e.g. Laplante 1989).

The hypothesis that the number of cerambycid species in Ontario has declined since 1950 is eminently testable. Focused collecting of cerambycids in the Carolinian forests of extreme southern Ontario, specifically the Niagara Peninsula, Long Point, Rondeau, Point Pelee, and Pinery, could provide the data. If many of the species in Table 2 were to be collected, the logical conclusion would be that the decline is more apparent than real, wheras if these species were not found, the contention that the decline is real would be supported.

Data on phenology, distribution, and abundance would be useful. The COSEWIC species at risk ranking (Committee on the Status of Endangered Wildlife in Canada 2004) for the 20 species only collected prior to 1950 and the 9 collected only between 1950 and 1999, would likely be 'Data Deficient'. The lack of information about population size, population trends, geographic range in Ontario, and the paucity of records would all contribute to this designation.

Challenges: Understanding wood boring beetles has not been a priority for the public, government agencies, or research institutions in Ontario or Canada. Phenology and host preferences of only a few species of cerambycids have been studied in Ontario (e.g. Hicks 1947; 1962; 1971; Gardiner 1954; 1955; 1957; 1975). Therefore specific habitat requirements and phenology in Ontario are largely unknown. With such a low priority, the opportunity to develop expertise has been limited. This lack of interest is not limited to the Cerambycidae, as shown by this quote from a recent book on forest insect pests in Canada: 'There is no current research being conducted in Forestry Canada on any of the wood-boring insects described in this chapter' (Safranyik and Moeck 1995). Since then, spurred by the detection of Brown Spruce Long-horned Beetle, *Tetropium fuscum*, in Nova Scotia and Asian Long-horned Beetle, *Anoplophora glabripennis*, in Illinois, New York, and recently Ontario, there has been a redirection of efforts by Canadian researchers (e.g. Allison et al. 2001; Peddle et al. 2002). If we are going to understand what changes are occurring in the Ontario cerambycid fauna, understand the reasons behind the changes and be prepared to detect novel introductions, it is necessary to consider native and introduced species, and have the expertise to identify both (Huber and Dang 2003).

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BEES OF THE GENUS *HYLAEUS* OF ONTARIO (HYMENOPTERA: APOIDEA: COLLETIDAE)

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Eight species of *Hylaeus* Fabricius are reported from Ontario: *H. affinis* (Smith), *H. annulatus* (Linnaeus), *H. basalis* (Smith), *H. bisinuatus* Forster, *H. mesillae* (Cockerell), *H. modestus* Say, *H. verticalis* (Cresson), and for the first time recorded for Canada, *H. nelumbonis* (Robertson). Five additional species, *H. fedorica* (Cockerell), *H. hyalinatus* Smith, *H. saniculae* (Robertson), *H. sparsus* (Cresson), and *H. rudbeckiae* (Cockerell & Casad) have also been reported in the researched area, but were not found in the collections examined. The *Hylaeus* flight period in Ontario starts in May and continues until the last warm days in autumn. Identification keys for male and female *Hylaeus* reported for Ontario are provided, in addition to information on phenology and locality records.

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Introduction

There has been no comprehensive study of *Hylaeus* Fabricius (Colletidae) in Ontario, but separate records of species found in the province are scattered in the literature (Fye 1965; MacKay and Knerer 1979; Mitchell 1960; Usui 1994). As a result of studying this group of bees at the largest collections of eastern Canada, knowledge about the distributional ranges of discussed species has been considerably expanded. The material examined yielded eight *Hylaeus* species from Ontario. At least five more species are likely present in the province. Three of these have been recorded in the literature from Ontario: *H. saniculae* (Robertson) (Mitchell 1960; Snelling 1970; Hurd 1979), *H. rudbeckiae* (Cockerell & Casad) (Mitchell 1960), *H. hyalinatus* Smith (Buck et al. 2005). In addition, *H. fedorica* (Cockerell) has been recorded from "Canada" (Metz 1911, as *H. grossicornis*). Finally, *H. sparsus* (Cresson) has been recorded "from southeastern Canada" (Snelling 1968). The first annotated list of Ontario *Hylaeus* is presented herein, with distribution maps compiled from studied specimens, and identification keys to the species for both males and females.

Materials and Methods

All specimens examined are deposited in the entomological collections of the Royal Ontario Museum (ROME), University of Guelph (DEBU), Canadian National Collection of Insects (CNCI), University of Manitoba (EDUM), University of California (UCRC), and North Carolina State University (NCSU). Wooden trap nests were also used by the author to obtain additional material (Krombein 1967). Species morphological characteristics, flight periods, and distribution data are based on specimens from these collections. Since I have not examined any specimens of the additional species recorded for Ontario, the characters given for them in the keys are taken from published descriptions or rely on examined specimens from other regions (Ascher 2001; Metz 1911; Mitchell 1960; Osychnyuk 1978). The distributional data are presented in the form of an annotated list and are illustrated with maps. The locality records in the annotated lists are arranged from north to south according to Ontario's primary administrative divisions, but the terms "county", "district", etc., are omitted. Distribution records from outside Ontario are given according to studied collections and literature records (Ascher 2001; Buck et al. 2005; Dathe 1994; Hurd 1979; Metz 1911; Mitchell 1960; Snelling 1966 a,b, 1968, 1970). The morphological terms used in this paper were defined and illustrated by Michener (1944, 2000). The abbreviations are as follows: F–flagellar segment, T–metasomal tergum, S–metasomal sternum. An asterisk designates a species record new for Ontario (and Canada). More than 2500 specimens were identified using Metz (1911) and Mitchell (1960). All existing determinations in the studied collections were checked.

Genus *Hylaeus* Fabricius

Ontario bees of the genus *Hylaeus* are distinguished from other members of the provincial bee fauna by the following combination of characters: small to medium size (4-9 mm); integument black, shiny, without noticeable pubescence; head, pronotum, tegulae, and legs usually with yellow markings, which are more extensive in males; scopa absent.

Like other Holarctic Colletidae, *Hylaeus* are defined by their short, truncate, bilobbed glossa, and subantennal suture meeting the antennal socket at its inner side.

The flight period extends from May until the last warm autumn days.

Many *Hylaeus* species nest in hollow dead stems, others use different pre-existing cavities (in wood, ground, etc.). Nest cells are made of cellophane-like secretion. Although females have no scopa, pollen and nectar are carried in the crop. Provisions in cells are liquid, and the egg floats on the surface of the provisions. Polylectic.

Key to *Hylaeus* species of Ontario

The brief species descriptions that follow the dashes in the couplets refer only to the most distinctive characteristics for the particular species. Some frequently encountered synonyms are given in brackets following the species name in the key. Distributional and flight period data are included in the male key. Only males generally can be identified with

confidence; the identification of females is often tentative except for a few species (Metz 1911; Mitchell 1960).

Males. Clypeus always yellow. Antennae with 13 segments. Scape modified or not.

1. Mesepisternum with lamelliform carina between anterior and lateral faces. —S8 spatulate, protrudes conspicuously from genital opening in combination with long slender gonostyli that extend far beyond apices of penis valves. T1 with white hair fringes laterally on posterior margin. Malar area as long as basal mandibular width. Body length 5-6 mm. Ontario: June–August. —Palearctic. New York .... ***H. hyalinatus*** Smith
– Mesepisternum without lamelliform carina **2**
2. Front coxae angulate or toothed laterally. —Genal area not shorter than eye width. Scape maculated. Paraocular yellow markings abruptly truncate at level of antennae. Body length 6 mm. —Québec, New York, Michigan to Georgia, Texas... ***H. sparsus*** (Cresson)
– Front coxae simple **3**
3. S3 with central swellings. T1 with white hair fringes laterally on posterior margin **4**
– S3 without swellings. T1 with or without hair fringes on posterior margin **5**
4. Scape transverse, wider than long, outer half yellow. S2 with swellings. —Labrum and mandibles black. Supraclypeal area longer than half clypeal length. Antennal sockets surrounded with elevation. Genal area as wide as eye at its widest part. Pronotum and tegulae without yellow markings. T1 tessellate, with uniformly close, shallow, minute punctures. Body length 8-9 mm. Ontario: June–August. —Transcontinental (alpine in southern part of distribution) .... ***H. basalis*** (Smith)
– Scape longer than wide, curved, yellow antero-laterally. S2 without swellings. —Labrum and mandibles on inner margins yellow. Supraclypeal area not longer than half clypeal length. Paraocular yellow marking with inner angle extending beyond upper margin of antennal socket. Genal area narrower than eye width. Pronotal collar, pronotal lobes, and tegulae with yellow marks. T1 tessellate, with uniformly dense, shallow, minute punctures. Body length 4.5-6 mm. Ontario: June–September. —From British Columbia to Eastern Canada, south to Utah, Louisiana, Mississippi, Georgia .... ***H. affinis*** (Smith) (*Prosopis ziziae* Robertson)
5. Scape heart-shaped, with outer half yellow. —Paraocular yellow patches apically truncate, reaching upper edge of antennal sockets at middle. Labrum and mandibles without yellow markings. Supraclypeal area longer than half clypeal length. Genal area wider than half width of eye. F1 short, transverse; F2 longer than F1, transverse. Pronotal lobes with yellow markings, pronotal collar and tegulae without yellow markings. Mesepisternum with deep, dense punctures less than diameter apart. T1 without lateral hair fringes, tessellate, with evenly dispersed, minute, shallow punctures. Body length 5-6 mm. Ontario: May–August. —Holarctic, south to Georgia .... ***H.annulatus*** (Linnaeus) (*H. ellipticus* Kirby)
– Scape parallel-sided or completely black **6**

6. T1 with lateral white hair fringes on posterior margin. Scape without yellow marking 7
– T1 without hair fringes on posterior margin. Scape with or without yellow marking **8**
7. Paraocular yellow markings extending along inner eye margins. Supraclypeal area shorter than half clypeal length. Frons without impunctate spaces above antennal sockets. —Scape curved. Mandibles and labrum black to completely yellow. Genal area wider than half width of eye. Pronotal lobes and usually pronotal collar marked with yellow. Scutum and mesepisternum with punctures well separated, mostly diameter or more apart. T1 with dense fine punctures. Body length 4-6 mm. Ontario: May–September. —Alaska, transcontinental to California ....***H. modestus*** Say
– Paraocular yellow markings narrow apically, expand from eye margin to upper margin of antennal sockets. Supraclypeal area longer than half clypeal length. Frons above antennal sockets with large, shiny, impunctate spaces. —Scape about twice as thick as flagellum. Mandibles yellow, labrum black. Genal area equal to or narrower than width of eye. Pronotal lobes and tegulae with yellow markings. Mesepisternum with punctures more than diameter apart. T1 shiny, with sparse or dense, deep punctures. Body length 6-7 mm. Ontario: May–September. —Transcontinental ....***H. verticalis*** (Cresson)
8. Supraclypeal area shorter than half clypeal length. F1 as long as wide. —Scape and pronotal collar without yellow markings. F1 shorter than F2. Malar area flat, 3 times as wide as long. Genal area wider than half width of eye (4/5). Paraocular yellow markings narrowly round apically, terminated above antennal sockets. Pronotal lobes and tegulae with yellow markings. Scutum subrugose, with deep punctures less than diameter apart. Scutellum shiny, with well separated punctures. Mesepisternum hairy, with deep, large, confluent pits. Front tibiae outer and anterior faces, mid tibiae basal third, hind tibiae basal half, all spurs and tarsi yellow. T1 ferruginous, disk shiny, with punctures very sparse and obscure. S3 with slight central elevation. Body length 7 mm. —Ontario, Illinois, Ohio, south to Louisiana, Alabama, Florida ... .****H. nelumbonis*** (Robertson)
– Supraclypeal area longer than half clypeal length. F1 transverse **9**
9. Genal area not longer than half eye width. Mesepisternum with large, deep punctures irregularly spaced. T1 disk and sterna with deep, distinct and abundant punctures. —Paraocular yellow marking with upper extension slightly removed from eye margin. Mandibles and labrum black, or labrum with yellow spot. F1 short, transverse; F2 longer, slightly transverse; F3 elongate. Pronotal lobes, tegulae and often pronotal collar marked with yellow. Body length 4-6 mm. Ontario: June–August. —Holarctic, south to California, Georgia .....***H. bisinuatus*** Forster (*Prosopis stevensi* Crawford)
– Genal area wider than half eye width. Mesepisternum with small punctures diameter or less apart. T1 disk and sterna with sparse, shallow, minute punctures **10**
10. Mesepisternum shiny, tessellate, with deep punctures a diameter or less apart. Paraocular areas elevated apically at antennal sockets. Face with depressions above paraocular areas. —Scape and pronotum without yellow markings. F1 and F2 much shorter than wide, F3 slightly transverse. Propodeum with long basal area wrinkled. Body length 3.5-4 mm. —Ontario, Nova Scotia, to Minnesota, Tennessee, Georgia ... .***H. saniculae*** (Robertson)

– Mesepisternum shagreened, with shallow punctures. Paraocular area not elevated. Face without depressions above paraocular areas **10**

11. Paraocular yellow marking narrowly tipped, ending at side of antennal socket. — Propodeal triangle mostly smooth, shagreened, with short, fine wrinkles basally. — Scape with yellow strip anteriorly. Pronotal lobes without yellow markings. Body length 4-5 mm. —Michigan, Minnesota, to Texas, North Carolina ....***H. fedorica*** (Cockerell) (*Prosopis grossicornis* Swenk & Cockerell)

– Paraocular yellow marking narrowed at antennal socket, then clavate, bent towards upper margin of antennal socket. Propodeal triangle mostly wrinkled **12**

12. Paraocular yellow marking with constriction wider than distance to inner orbit. Pronotal lobes with yellow markings. —Scape with or without yellow marking. F1 and F2 transverse, F1 little shorter than F2, F3 elongate. Pronotal collar black. Body length 4-5 mm. Ontario: May–October. —Transcontinental, to northern Mexico ....***H. mesillae*** (Cockerell) (*Prosopis cressoni* Cockerell; *P. telepora* Lovell)

– Paraocular yellow marking strongly constricted, separated from inner orbits by much more than its minimum width at constriction. Pronotal lobes black. —Scape without yellow marking. F1 half as long as F2, or shorter. T1 with distinct, regularly spaced punctures; central impunctate space distinctive. Body length 4.5 mm. — Transcontinental ....***H. rudbeckiae*** (Cockerell & Casad)

Females. Clypeus black, rarely yellow apically. Antennae with 12 segments. Scape not modified. Separation of *H. modestus* and *H. affinis,* as well as *H. mesillae* and *H. rudbeckiae* is doubtful.

1. Mesepisternum with lamelliform carina between anterior and lateral faces. —Malar area not shorter than half basal mandibular width. Mesepisternum with punctures diameter or more apart. T1 with white hair fringes laterally on posterior margin. Body length 5.5-6.5 mm ....***H. hyalinatus*** Smith

– Mesepisternum without lamelliform carina between anterior and lateral faces **2**

2. T1 without hair fringes laterally on posterior margin **3**

– T1 with white hair fringes laterally on posterior margin **6**

3. Supraclypeal area narrowed between antennal sockets, raised apically and joining frons at 45° angle. —Clypeus often with apical yellow patch. Genal area wider than half eye width. F1 and F3 subequal, about as long as wide; F2 shorter, transverse. Mesepisternum with small, deep punctures, diameter or less apart. T1 disk shiny, with scattered fine punctures. Body length 5-7 mm ....***H. annulatus*** (Linnaeus)

– Supraclypeal area not narrowed between antennal sockets, not swollen apically **4**

4. Pronotal collar with yellow markings. Genal area equal to or narrower than half width of eye. —F1 elongate, F2 short, transverse, F3 slightly transverse. Pronotal lobes and tegulae marked with yellow. Mesepisternum with large, deep, irregularly spaced punctures. T1 disc impunctate medially, anteriorly, and laterally with minute punctures. Body length 4-6 mm ....***H. bisinuatus*** Forster

– Pronotal collar usually without yellow markings. Genal area wider than half width of eye. T1 disk shiny, with sparse, tiny punctures medially, dense laterally **5**

5. T1 ferruginous. Malar area flat, three times as wide as long. Mesepisternum with large, well separated to confluent pits. —Genal area as wide as eye width. F2 transverse, F1 and F3 subequal, as long as wide, little longer than F2. Scutal punctures less than a diameter apart. Scutellum shiny, with punctures about a diameter apart. Hind tibiae yellow basally, fore and mid tibiae sometimes with yellow basal spots. Body length 6-7 mm .... ***H. nelumbonis*** (Robertson)

– T1 black. Malar area linear. Mesepisternum tessellate, with shallow punctures less than diameter apart **6**

6. Pronotal lobes yellow. —Propodeum mostly wrinkled. F2 and F3 transverse, shorter than F1. Body length 4-5 mm .... ***H. mesillae*** (Cockerell), ***H. rudbeckiae*** (Cockerell & Casad)

– Pronotal lobes without yellow markings **7**

7. Propodeal triangle mostly smooth, shagreened, with short fine wrinkles basally. —F1 as long as F3, slightly transverse; F2 much shorter, transverse. Body length 4.5 mm .... ***H. fedorica*** (Cockerell)

– Propodeal triangle with long basal area wrinkled. —F1 as long as F3, or longer; F2 and F3 transverse. Body length 4.5 mm .... ***H. saniculae*** (Robertson)

8. Genal area equal to or wider than width of eye. Pronotal collar usually without yellow markings. T1 disk centrally punctured or not **9**

– Genal area narrower than width of eye. Pronotal collar with yellow markings. T1 disk impunctate centrally **11**

9. Genal area as wide as eye width. —F1 longer than F3, F2 short, transverse. Integument with yellow markings. Pronotal lobes and tegulae with yellow markings. Mesepisternum with small, deep punctures, more than diameter apart. T1 shiny, with punctures scattered on disc centrally, dense on sides, or punctures almost invisible. Body length 6-7 mm .... ***H. verticalis*** (Cresson)

– Genal area wider than width of eye **10**

10. Integument with yellow markings. Front coxae toothed or spinose on outer side. Mesepisternum shiny, with small punctures a few diameters apart. —F1 as long as F3, F1 as long as wide, F3 slightly transverse; F2 short, transverse. T1 shiny, with sparse, obscure, exceedingly minute punctures. Body length 6-7 mm. .... ***H. sparsus*** (Cresson)

– Integument completely black. Front coxae not spinose. Mesepisternum with deep punctures less than or equal to diameter apart. —F1 as long as F3, F2 transverse. T1 shiny, with punctures very fine and shallow. Body length 7-9 mm .... ***H. basalis*** (Smith)

11. Mesepisternum with punctures more than diameter apart. Body length 5-6 mm .... ***H. affinis*** (Smith)

– Mesepisternum with punctures equal to or less than diameter apart. Body length 6-7 mm .... ***H. modestus*** Say

Annotated list of Ontario *Hylaeus*

The species are listed in alphabetical order. The abbreviations of the names of the collectors are as follows: AR–W. Attwater; AT–C. Atwood; BG–N. Bigelow; BK–M. Buck; BL–S. Beiley; BR–K. Barber; CL–S. Clark; ED–C. Edwards; GL–T. Galloway; KL–L. Kelton; KN–G. Knerer; MK–P. MacKay; MN–J. Martin; PA–S. Paiero; PG–D. Pengelly; RM–T. Romankova; SL–F. Sladen; US–M. Usui.

1. *H. affinis* (Smith)

Kenora: Oneside Lake, 25 July 1960, ♂, CL; Jordan, 13 June–28 July 1914, 3♂, Ross (CNCI). **Rainy River:** Pinewood, 22-28 June 1960, 3♂, KL; Fort Frances, 15 June 1960, ♂, KL (CNCI). **Thunder Bay:** Fort William, 2 June 1915, ♀, SL, det. H. Viereck (CNCI). **Algoma:** Black Lake, 29August 1970, ♂, J. MacAlpine (CNCI). **Parry Sound:** North Bay, 9 June 1963, ♂, W. Gague (CNCI). **Renfrew:** Calabogie, 14 June 1978, ♂, M. Gunderman (ROME); Rackett, 6 August 1953, ♀, PG (CNCI). **Carleton:** Merivale, 7 August 1958, ♂, M. Prime (DEBU); Ottawa, 8 June 1970, ♀, N. Mills; 22 August 1958, ♂, KL; 12-20 June 1913, ♂, ♀, SL, det. Swenk (CNCI). **Russell:** Limoges, 19 July 1978, ♀, E. Fuller, R. Jaagumagi (ROME). **Leeds:** Chaffeys Locks, 10 July 1963, ♀, J. Riotte, I. Smith (ROME); St. Lawrence Isl., 31 July–14 August 1975, 3♂ (CNCI). **Frontenac:** Perth Road, 18 August 1957, ♂, J. Vockeroth (CNCI). **Hastings:** Marmora, 24 June–23 July 1952, 4♂, Ross (CNCI); Belleville, 26 June 1949, ♂, MN; 15 August 1948, ♂, MN; Trenton, 27 August 1905, ♂, Evans (CNCI). **Haliburton:** Algonquin Park, 14 August 1903, 2♀, EMW (ROME). **Muskoka:** Severn Bridge, 9 July 1965, ♀, R. Scott (ROME). **Peterborough:** Peterborough, 26 June 1975, ♀, F. Quan (ROME); Serpent Mounds P. P., 8 August 1983, ♀, ♂, GL (EDUM). **Durham:** Kendal, 19 June 1960, ♀, KN, *Rubus* (ROME). **Simcoe**: Simcoe, 19 June 1989, ♂, Walley (CNCI). **York:** Toronto, 4 June 1959, ♀, ♂, *Allium*; 14 June 1914, ♀; 7 July 1949, ♀; ♀, W. Brodie (ROME); 30 July 1953, ♂, M. Hearst (DEBU); 7-14 June 1896, ♂; 4♀, 30 July 1893, ♂; 21 June 1892, ♀; 19 July 1891, ♂; 14 August 1890, 2♂; 19 August–2 September 1888, 2♂ (CNCI); Vivian, 22 June 1961, 2♀, KN, *Brassica* (ROME). **Bruce:** Sauble Beach, 31 July 1977, ♀, W. Maddison; Tobermory, 3-5 August 1977, 2♂, 5♀, W. Maddison; 10 July 1960, ♀, KN (ROME); Hepworth, 27 June 1979, 2♂, B. Wit; Dyers Bay, 22 August 1952, ♀, PG (DEBU). **Dufferin:** Primrose, 19, 27 July 1977, ♂, AR (DEBU). **Peel:** Terra Cotta, 25 July 1999, 7♂, 5♀, RM ; HWY 25 and Burhumthorp Rd., 2001, 3♂, 4♀, from nests, TR; Forks of the Credit, 16 June–29 August 1969, 26♂, 113♀, MK; 4 June–12 August 1968, 42♂, 125♀, MK; 22-28 June1965, 5♂, 11♀, KN (ROME). **Wellington:** Guelph, 3 July 1973, ♂, PG; 13 June 1979, ♂, D. Levis; 26 June 1978, ♂, ♀, M. Lichtenberg; 16-23 June 1978, 2♂, BR; 23 August 1977, ♂, BR; 30 May 1962, ♂, KN; 7 August 1952, ♀, PG; Arkell, 6 June 1978, 2♂, S. Ball; 8 June 1978, ♂, N. Pierce; 26 May 1977, 2♂, BR; 11 June 1958, ♂, PG; 25 July 1952, ♂, PG (DEBU). **Halton:** Hilton Falls, 16 July 1999, ♀, RM; Speyside, 12 August 1999, ♂, ♀, RM (ROME); Burlington, 6 June 1984, ♂, B. Sinclair; Oakville, 5 July 1978, ♂, P. Jursevskis (DEBU). **Huron:** Goderich, 20 July 1977, 3♀, W. Maddison (ROME); Kinburn, 26 July 1957, ♂, MN (CNCI). **Wentworth:** Dundas, 25 June 1980, ♂, S. Beierl; 19 June 1978, ♂, S. Ball; Hamilton, 25 June 1979, ♀, K. Runciman; 27 June 1980, ♂, S. Beierl (DEBU). **Lincoln:** Grimsby, 19 June 1979, ♂, M. Bailey; Vineland, 26 June 1956, ♂, C.

Small (DEBU); Grassie, 31 May 1962, ♂, KL (CNCI). **Welland:** Effingham, 1 September 1954, ♂ (CNCI). **Brant:** Ohsweken, 19 June 1979, ♂, D. Morris; Brantford, Railway Prairie, 24 August 2001, ♀, PA (DEBU). **Haldimand:** Long Point, 3 June 1983, 2♂, T. Thompson (ROME, DEBU); 18 June 1962, ♂, G. Thorpe; Dunnville, 5 August 1954, ♂, C. Miller; Cayuga, 12 July 1925, ♂ (CNCI). **Middlesex:** Komoka, Feed Mill Prairie, 11 July–11 September 2001, 5♂, ♀, PA (DEBU). **Elgin:** New Glasgow, 27 June 1961, 3♂, KL (CNCI). **Norfolk:** Turkey Point, 4 July 1962, ♂, G. Thorpe; Normandale, 4 September 1954, ♂, R. Lambert (CNCI); Delhi-Simcoe Railway, 7-21 September 2001, ♂, PA, prairie (DEBU). **Kent:** Rondeau Park, 16-21 June 1977, ♂ 2♀, (ROME). **Essex:** Point Pelee, 25 July 1979, ♀; 23 June 1920, ♀, BG (ROME); 25 July 1979, ♀, AR; 8 September 1954, ♂, KL (CNCI); Kingsville, 23 May 1962, ♂, KL (CNCI); 8 July 1977, ♂, BR; Windsor, Ojibway Prairie, 5 June–21 September 2001, 2♂, 2♀, PA (DEBU); Leamington, 4-7 August 1985, 12♂, GL, 14 July–18 August 1987, 2♂, GL, (EDUM). Figure 1.
Localities other than Ontario: British Columbia, Manitoba, Saskatchewan, Québec, Colorado, Wisconsin, Michigan, New York (CNCI, ROME).

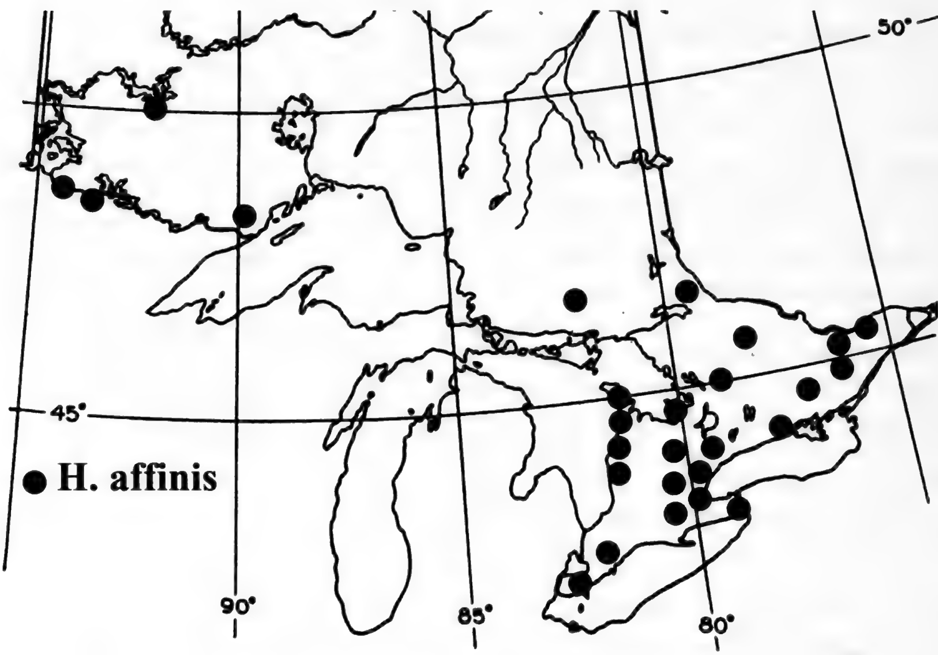

FIGURE 1. Ontario collection localities of *Hylaeus affinis*.

2. *H. annulatus* (Linnaeus)
Kenora: Kenora, 13 June 1960, ♂, KL; Oneside Lake, 24 June–27 July 1960, 7♂, CL; Black Sturgeon Lake, 1963, 303♂ & ♀ (CNCI); Vermilion Bay, Cedar Lake, 10 August 1959, ♀, E. Cameron (DEBU). **Rainy River:** Gold Rock, 22 July 1905, ♀, H. Newcomb,

det. Stephen (EDUM); Pinewood, 22 June 1960, 4♂, KL; Finland, 21 July 1960, ♂, KL (CNCI). **Thunder Bay:** Macdiarmid, 22 June 1921, ♀, BG (ROME); Manitouwadge, 12 June 1977, ♂, M. Eimann (DEBU). **Cochrane:** Iroquois Falls, 10 August 1961, 2♀, KN, *Solidago* (ROME); 22 June 1987, ♂, J. Vockeroth (CNCI); Porquis, 10 August 1961, ♀, KN; Abitibi, Low Bush, 30 June–19 July 1925, 2♂, 3♀, BG (ROME). **Algoma:** Wawa, 7 August 1992, ♀, D. Bennett; 13 June 1977, ♀, BR; 2 August 1976, ♀, P. Heel; Erickson, 7 August 1979, 2♀, PG; Otasawian Lake, 17 August 1963, 3♀, KN (DEBU). **Sudbury:** Sudbury, 1892, 3♀ (CNCI); Chapleau, 10 June 1992, ♂, US; 5 June 1991, 2♂, US; 1 July 1990, ♀, US (DEBU). **Timiskaming:** Haileybury, 7 May 1916, ♀, SL (CNCI). **Nipissing:** Belwood, 23 June–13 July 1965, 3♀, ED (DEBU); Temagami, 22 July 1932, ♀, A. Brown (ROME). **Parry Sound:** Sand Lake, 30 June 1926, ♂, F. Ide; Burk's Falls, 15 July 1926, ♂, F. Ide (CNCI); Killbear Park, 20 August 1978, 2♀, AR (DEBU). **Renfrew:** Petawawa, 7 June 1961, ♂, J. Vockeroth (CNCI). **Lanark:** Bells Corners, 29 June 1945, ♂, O. Peck (CNCI). **Carleton:** Ottawa, 17 July 1963, ♀, KN (ROME); 2 May–29 July 1913, 8♂, SL (CNCI); 5-16 June 1913, 4♂, ♀, SL (DEBU); 12-20 June 1913, 2♀, SL (EDUM). **Glengarry:** Algonquin Park, 14 August 1903, ♀, EMW (ROME). **Leeds:** St. Lawrence Isl., 18 July 1975, ♂, C. Curran (CNCI). **Hastings**: Marmora, 11 July 1957, ♀; 9 June 1957, ♂, K. Southern (DEBU); 12-24 July 1952, 2♂, J. Vockeroth; Trenton, 30 June 1905, ♀; 22 June 1902, ♂, Evans (CNCI). **Muskoka:** Port Sydney, 24 June–11 July 1919, 2♀, BG (ROME). **Simcoe:** Orillia, 18 June 1924, ♂ (CNCI). **Bruce:** Sauble Falls, 24 July 1977, ♂, W. Maddison (ROME); Crane River, 16 July 1977, ♀, D. Murrell; Tobermory, 30 May 1998, ♂, D. Vaccari; Sauble Beach, 8 July 1981, ♀, G. Aiudi; Dyers Bay, 24 July 1954, ♀, PG; 7 July–15 August 1953, 10♀, PG (DEBU). **York:** Toronto, 17 July–1 August 1891, 5♀ (CNCI); 23 June 1990, ♀; 7 June 1914, ♀, E. Walker; 19-28 July 1891, 2♀; 3 July 1890, ♀ (DEBU); 7 July 1949, ♂, (ROME). **Dufferin:** Primrose, 27 July 1977, ♂, AR (DEBU). **Peel:** Forks of the Credit, 4 July–18 August 1968, 28♀, MK; 2 July 1969, ♂, MK; ♀; Terra Cotta, 2001, 3♂, 15♀, RM, from nests in wood (ROME). **Wellington:** Arkell, 7 June 1960, ♂, PG; 25 July 1965, ♂, PG; Guelph, 3 June 1974, ♂, I. Kigatiira; 20 August 1979, ♂, J. Ernst; 11 August 1977, 2♀, D. Murrell; 17 August 1976, ♀, D. Levin; 2 August 1977, ♀, D. Levin; 14 June 1965, 2♀, 2♂, ED (DEBU). **Halton:** Hilton Falls, 16 July 1999, ♂, 3♀, RM; Speyside, 12 August 1999, ♂, ♀, RM (ROME); Halton, 5 August 1981, ♂, G. Aiudi (DEBU); Milton, 9 June 1978, 2♂, J. Heraty; Campbellville, 10 June 1977, 2♀, AR (DEBU). **Huron:** Brussels, 22 July 1963, ♀, J. VanLoon (DEBU); Kinburn, 26 July 1953, ♂, MN (CNCI). **Waterloo:** Oliver's Marsh [Oliver Bog], ♀ (DEBU). **Wentworth:** Borer's Falls, 1 June 1978, ♂, N. Kevin (DEBU); Freelton, 27 July 1984, ♂, M. Kasserra (DEBU). **Lincoln:** Grimsby, 17 June 1894, ♀ (CNCI). **Haldimand:** Cayuga, 6 August 1952, ♀, PG (DEBU). **Essex:** Kingsville, 9 July 1977, ♀, AT (DEBU); 23 May 1962, ♂, KL (CNCI). **Locality unknown:** SSH, 19 August 1981, ♀, G. Aiudi (DEBU); Ontario, 2 June 1906, ♀ (DEBU); 7 June 1961, ♂, J. Chillcott (CNCI). Figure 2.

Localities other than Ontario: Alaska, Yukon, North West Territories, British Columbia, Alberta, Saskatchewan, Manitoba, Québec, New Brunswick, Nova Scotia, Utah (CNCI, DEBU, ROME).

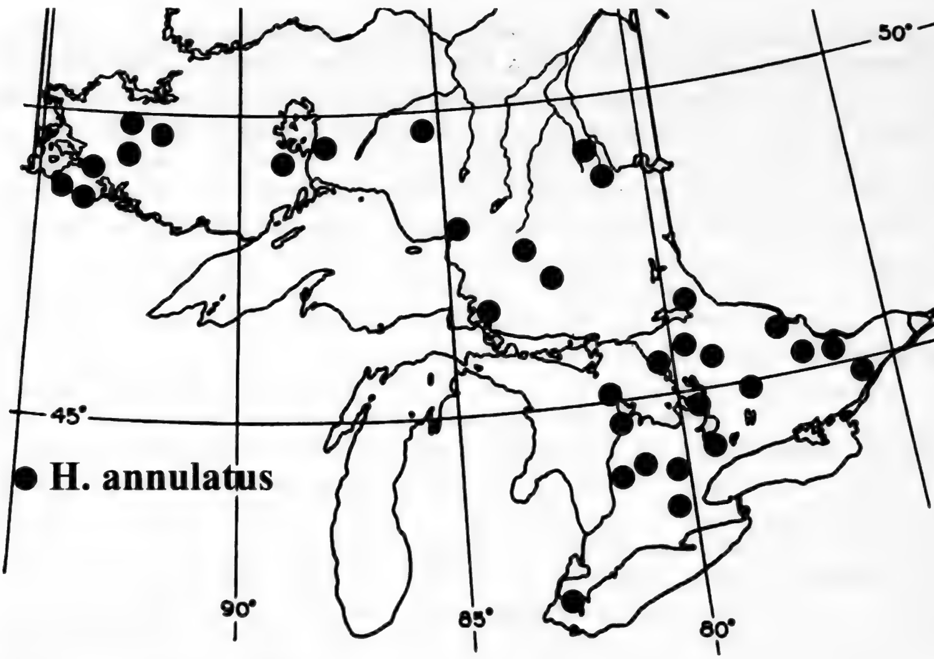

FIGURE 2. Ontario collection localities of *Hylaeus annulatus*.

3. *H. basalis* (Smith)

Kenora: Oneside Lake, 19 July 1960, ♀, CL (CNCI); Martin, 20 July 1984, ♂, 2♀, ROM field party (ROME); 20 June 1984, ♂, 2♀, R. Jaagumagi (DEBU). **Thunder Bay:** Nipigon, 25 June 1895, ♂, J. Fletcher; Black Sturgeon Lake, 30 June 1962, 4♂, 2♀, (CNCI). **Cochrane:** Abitibi Lake, Low Bush, 20 June–17 July 1925, 7♂, 7♀, BG (ROME); Mattagami River, Smoky Falls, 22 June 1936, ♂, G. Walley (CNCI). **Algoma:** Sault Ste. Marie, 7 July 1963, ♀, D. Stotz (DEBU). **Sudbury:** Sudbury, 1892, ♂; 10 August 1887, ♂ (CNCI); Chapleau, Racine Lake, 11 June 1992, 4♀, US; 4 June 1991, ♀, US; 5 June–3 August 1990, 3♂, 11♀, US, on Early Goldenrod (DEBU). **Timiskaming:** Haileybury, 7 July 1916, ♀, SL (CNCI). **Carleton:** Ottawa, 5 June–1 July 1913, ♂, 4♀, SL.; 1 July 1885, ♀; ♀ (DEBU); 14 June 1917, ♀, SL; 13 June–22 July 1913, 4♂, 4♀, SL (CNCI). **Hastings:** 25 July 1902, ♀, Evans (CNCI). **Haliburton:** Dorset, 20 August 1961, 3♀, KN (ROME). **Muskoka:** Macdiarmid, 12-19 June 1921, 6♂, 8♀, BG (ROME). **York:** Toronto, 20 July 1893, ♀; 19-26 July 1891, 4♀; 4 June 1883, ♂ (CNCI). **Bruce:** Dyers Bay, 25 July 1954, 2♂, 3♀, PG (DEBU). Figure 3.

Localities other than Ontario: Yukon, North West Territories, British Columbia, Alberta, Saskatchewan, Manitoba, Québec, New Brunswick, Nova Scotia, Wisconsin (CNCI, DEBU).

4. *H. bisinuatus* Forster

Algoma: Sault Ste. Marie, 13 July 1963, ♀, D. Stoltz (DEBU). **Grenville:** Prescott, 29 May 1977, ♀, BR (DEBU). **Haliburton:** Dorset, 16 August 1961, 2♀, KN, *Solidago* (DEBU).

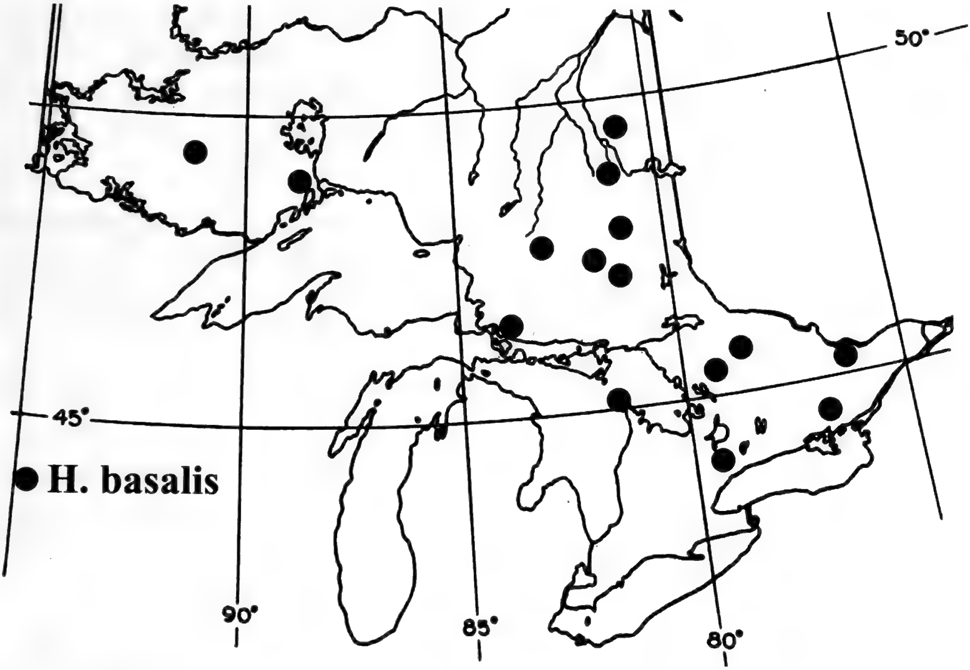

FIGURE 3. Ontario collection localities of *Hylaeus basalis*.

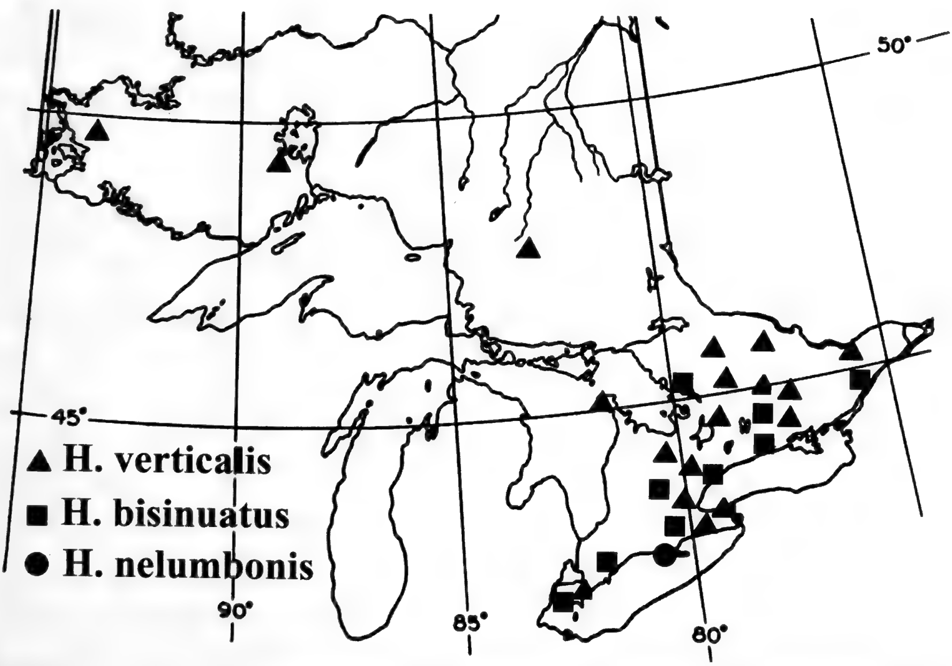

FIGURE 4. Ontario collection localities of *Hylaeus*: *H. bisinuatus*, *H. nelumbonis*, and *H. verticalis*.

Victoria: Norland, 18 July 1961, ♀, PG (DEBU). **Durham:** Kendal, 12 July 1961, ♂, KN (ROME). **Simcoe:** Midland, 9 June 1974, ♂, J. Huber (DEBU). **Bruce:** Dyers Bay, 19 July–17 August 1953, 2♀, PG; 10-28 July 1952, 2♀, PG (DEBU). **York:** Toronto, 11 July 1999, ♂, RM (DEBU). **Peel:** HWY 25 and Burnhamthorpe Road, 2001, 3♂, 4♀, RM, from nests in wood (ROME). **Wellington:** Arkell, 24 June 1952, ♀, PG; Guelph, 14 June 1954, ♀, R. Crawford; 7 August 1994, ♂, A. Rios; 12 July 1978, ♂, D. Morris; 9 June 1976, ♂, C. Miller; 29 June 1965, ♂, ED; 9 July 1961, ♂, S. Canetti (DEBU). **Haldimand:** Cayuga, 25 August 1952, ♂, PG (CNCI). **Lambton:** Sarnia, Clear Water Nature Trail, 12 September 2001, ♀, PA (DEBU). **Kent:** Fargo, 3 July 1959, ♀, ♂, PG (DEBU). **Essex:** Leamington, 18-19 August 1983, 4♂, 2♀, GL; 7 August 1985, ♂, ♀, GL; 17 August 1987, ♀, GL (EDUM). Figure 4.
Localities other than Ontario: British Columbia, Alberta, Manitoba, California (CNCI, DEBU, ROME).

5. *H. fedorica* (Cockrell)
UNITED STATES, North Carolina: Raleigh, 24 April 1954, 2♂, T. B. Mitchell, on *Pyracantha* (NCSU); 25 June 1950, ♀, on *Daucus carrota* (NCSU). **Texas**: Dallas, 17 March 1907, ♂, R. A. Cushman Coll. [*Prosopis grossicornis* Swenk & Cockerell] (UCRC).

6. *H. hyalinatus* Smith
Halton: Oakville, 16 Mile Creek nr Hwy 407, 21 August 2004, ♂, ♀, 25 June 2005, ♂, M. Buck (DEBU). **Essex:** W of Harrow, 28 June 1993, ♂, J. Doherty.

7. *H. mesillae* (Cockerell)
Kenora: Oneside Lake, 25 June–26 August 1960, 3♂, CL (CNCI). **Rainy River:** Rainy River, 5 June–3 August 1960, 7♂, CL; Finland, 11-21 June 1960, 2♂, CL (CNCI). **Thunder Bay:** Schreiber, 16 August 1962, ♀, KN, *Solidago* (DEBU). **Sudbury:** Chapleau, Racine Lake, 6 July 1990, ♂, US, raspberry (DEBU). **Renfrew:** Petawawa, 7 June 1961, ♂, J. Vockeroth (CNCI). **Carleton:** Ottawa, 31 May 1914, ♀, SL; 5 May 1913, ♀, SL; 24 June 1913, ♀, SL (DEBU); 4 June–8 October 1913, 5♂, 6♀, SL; 15 August 1912, ♀; 2 September 1888, ♀; 4 June–7 July 1970, 2♀, N. Mills; 26 July 1955, ♂, P. Taschereau; Constance Bay, 30 June 1959, 2♂, CL; Mer Bleue, 23 June 1952, 3♂, Chevell (CNCI). **Leeds**: Morton, 2 August 1961, ♀, KN, *Apocynum* (DEBU); St. Lawrence N. P., 20 August 1975, 3♂, Sigler (CNCI). **Hastings**: Marmora, 26 May 1952, ♂, R. Lambert (CNCI). **Haliburton**: Dorset, 16 August 1961, ♂, KN (ROME). **Muskoka**: Barrie, 16 July 1961, ♀, KN, *Rhus* (ROME). **Peterborough**: 5 July 1977, ♂, ♀, GL; Serpent Mounds P. P., 8 August 1983, ♂, GL (EDUM). **Victoria**: Coboconk, 14 August 1961, ♀, KN, *Rhus*; Norland, 18 July 1961, ♀, KN, *Solidago* (DEBU). **Northumberland**: Brighton, 13 July 1956, ♂ (CNCI). **Simcoe**: Barrie, 16 July 1961, ♀, KN (ROME). **York**: Toronto, 31 May 1914, ♂; 30 June 1913, ♀, SL; 17 June 1896, ♂; 16-30 July 1893, 2♀; 19 June–2 September 1891, 4♂, 4♀; 13 July 1890, ♀; 9 September 1888, ♂ (CNCI); 1 July 1999, ♂, RM (ROME); 2 August 1991, ♂; 20 June 1892, 2♂; 14 June 1891, ♂; Keswick, 18 June 1976, ♂ (DEBU). **Bruce**: Dyers Bay, 14 August 1952, 2♂, ♀, PG; 7 July 1953, 2♀, PG (DEBU); Kincardine, 28 May 1962, 3♂, KL (CNCI). **Peel**: Forks of the Credit, 14 June–3 September 1968, 1969, 18♂, 44♀, MK, *Melilotus*, *Rhus*, *Prunus* (ROME). **Wellington**: Guelph, 4 August 1979, ♂, D. Murrell; 20

July 1974, ♀, J. Huber; 12 July 1965, ♀, ED; 9 July 1961, ♂, S. Caultti; 26 June 1956, 3♀, PG; Arkell, 28 July 1952, ♂, PG; 23 June 1959, ♀, PG (DEBU). **Halton**: Georgetown, 30 August 1893, ♂ (CNCI). **Huron**: Kinburn, 26 July 1957, ♂, MN (CNCI). **Wentworth**: Spencer Creek, 7 September 2003, ♀, RM (ROME). **Lincoln**: Vineland, 7 June 1928, 2♂ (CNCI); Jordan, 24 August 1961, ♂, G. Brumpton (DEBU). **Waterloo**: Oliver's Marsh [Oliver Bog], 21 August 1987, 2♀, D. Blades (DEBU). **Welland**: Wainfleet Bog, 14 September 1987, ♀, Stirleeng (DEBU). **Brant**: Ohsweken, 19 June 1979, ♂, D. Morris (DEBU). **Haldimand-Norfolk**: Cayuga, 26 June 1911, ♂, PG; Delhi-Simcoe Railway, 27 July 2001, ♀, PA (DEBU). **Kent**: Rondeau P. P., 16 June 1977, ♀, field party (ROME). **Essex**: Kingsville, 17 July 1955, 2♂, KL; Point Pelee, 4 June 1951, ♂; 21 June 1927, ♂, F. Ide (CNCI); Harrow, 6 September 1959, ♀, PG; 22 August 1972, ♀, J. Huber; River Canard, 10 July 1977, ♀, AR; Ojibway, 17 June 1980, ♂, D. Krailo (DEBU); Leamington, 18 August 1983, ♂, GL; 4-7 August 1985, 5♀, 13 ♂, GL; 18 August 1987, 5♂, GL (EDUM). **Locality unknown**: Crinif Bog, 8 May 1987, 2♂, D. Blades; Figure 5.
Localities other than Ontario: North West Territories, British Columbia, Alberta, Saskatchewan, Manitoba, Québec, Wisconsin (CNCI, DEBU).

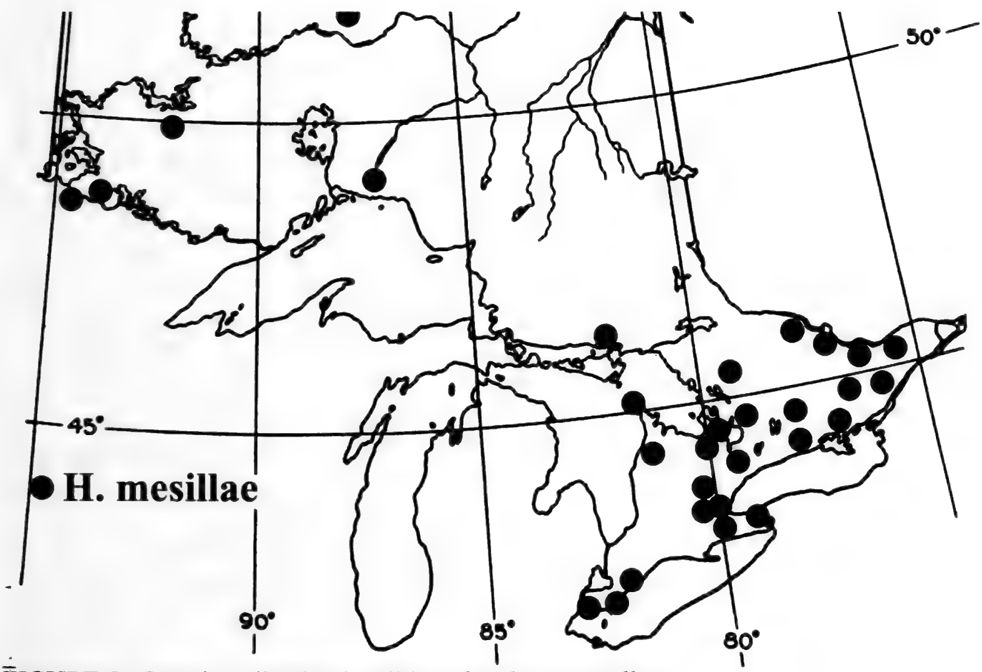

FIGURE 5. Ontario collection localities of *Hylaeus mesillae*.

8. *H. modestus* Say
Kenora: Oneside Lake, 9 July 1960, ♂ (CNCI); Martin, 20 August 1888, ♀; 20 June 1984, ♀ (ROME). **Rainy River**: Minahico, 27 July 1962, ♂, KL (CNCI). **Thunder Bay**: Healy

Falls, 7 July 1987, 2♀, GL (EDUM). **Algoma**: Wawa, 7 August 1992, ♀, D. Bennett; Algoma, 7 August 1977, ♀, Crins (DEBU). **Nipissing**: Opeongo Lake, 25 July 1981, ♀, Brown; Keswil, 5 June 1975, ♂, T. Sawingal (DEBU). **Parry Sound**: Killbear Park, 30 June 1979, ♂, AR; 17-20 August 1978, 2♀, AR; Powassan, 12 July 1978, 2♀, S. Ball; 11 July 1978, ♂, J. Cappleman (DEBU); Port Elwin, 8 June 1955, ♂ (CNCI). **Renfrew:** Hills, 14 July 1978, ♀, M. Lichtenberg (DEBU). **Carleton**: Merivale, 30 July 1958, ♀, M. Prime; Ottawa, 8 September 1913, ♀, SL; 12 June 1914, ♀, SL (DEBU); 22 July 1913, SL (EDUM); 22 July 1955 , ♂, P. Taschereau; 16♂, 29♀; Constance Bay (CNCI); 4 mi E Carp, 10 July 1950, 3♀, W. P. Stephen, *Lonicera* (EDUM). **Glengarry**: Alexandria, 13 July 1978, ♂, E. Fuller (ROME). **Grenville**: Prescott, 29 May–30 July 1977, 2♂, ♀, BR (DEBU). **Leeds**: Morton, 2 August 1961, ♂, KN, *Apocynum* (ROME). **Hastings**: Madoc, 23 July 1947, ♂; Marmora, 5 June 1952, ♂, CL; Trenton, 17 August 2000, 2♂; Belleville, 15 June 1962, ♂, KL; Bancroft, 18 June 1962, ♂, KL (CNCI). **Haliburton**: Haliburton, 11 September 1957, ♀, P. Muller; Dorset, 20 July–16 August 1961, 3♀, KN, *Solidago, Trifolium, Melilotus*; (DEBU). **Muskoka**: Port Sydney, 13 July–1 August 1919, 2♀, BG (ROME). **Peterborough**: Lakefield, August 1983, ♀, GL (EDUM). **Victoria**: Norland, 18 July 1961, 2♀, KN (ROME). **Northumberland**: Crowe Bridge, 18 July 1979, ♀, AR; 17 July 1979, ♀, BL; 18 July 1977, ♀, BL; Healey Falls, 18 July 1979, ♀, B. Wit (DEBU). **Simcoe**: Orillia, 25 July 1924, ♂, H. Viereck, (CNCI); Midland, 26 June 1970, ♀, J. Huber (DEBU). **York**: Oakwood, 18 July 1961, ♀, KN, *Melilotus*; Toronto, 1 July–18 August 1999, 2♂, 3♀, RM, *Vicia*; 27 June 1965, 2♀, KN (ROME); 16♂, 25♀ (CNCI); Leaside, 4 August 1961, 2♀, G. Brumpton (DEBU); ♀, KN, *Trifolium*; Hope, 15 June 1929, ♂, M. Dennis (ROME). **Bruce**: Tobermory, 6 August 1977, 2♀, D. Maddison; Bruce Peninsula, 10 July 1960, 2♀, KN, *Rhus* (ROME); 8 June 2000, ♀, C. Onodera; Sauble Beach, 9 July 1981, 8♀, G. Aiudi, Kircher (DEBU); Hepworth. **Grey**: Owen Sound, 4 July 1979, ♂, B. Wit; 21 August 1976, ♀, P. Heels (DEBU). **Peel**: Forks of the Credit, 2 July–21 August 1969, ♂, 233♀, MK; 14 June–23 July 1968, 35♂, 4♀, MK, *Melilotus;* 28 June 1965, 3♂, 11♀, KN (ROME); 26 June 1973, ♂, PG (DEBU); Terra Cotta, 25 July 1999, 6♂, 7♀, RM (ROME). **Wellington**: Ariss, 27 May 1962, ♂, KL; Niagara Falls, 8 June 1962, ♂, KL (CNCI); Belwood, 5-30 July 1972, ♂, ♀, PG; 5-16 July 1973, ♂, 5♀, PG; 19 June 1982, 2♂, PG; Arkell, 14 June 1973, ♂, PG; 26 May 1977, ♂, BR (DEBU); Guelph, 31 May 1962, ♂, 2♀, *Cornus, Helianthus* (ROME); 18 August 1964, ♀, B. Wyatt; 16 June–September 1994, 3♀, Brewen; 8 June 1991, ♀, M. Castillo; 22 July 1979, 2♀, J. Corrigan; 30 August 1978, ♀, Kreuzer; 5 July 1977, 2♀, AR; 23 July–23 August 1977, 2♂, BR; 12 July 1974, ♂, J. Huber; 27 June 1974, ♂, Kigatiira; 22 July 1974, 3♀, Eden; 19 August 1973, ♂, Smith; 4 July 1956, ♀, PG; Rockwood, 12 June 1981, ♂, Kircher (DEBU). **Halton**: Speyside, 12 September 1999, 4♂, 4♀, PM; Hilton Falls, 16 July 1999, 2♀, RM (ROME); Oakville, 31 July 1976, ♀, AR; Milton, 9 June–6 July 1978, 3♀, Heraty; 27 June 1979, 3♂, J. Huber; Halton, 6 July 1978, ♂, ♀, J. Cappleman; Campbellville, 10 June 1977, ♂, BR (DEBU). **Huron**: Maitland, 20 July 1977, 5♀ (ROME). **Perth**: Listowel, 27 May 1965, ♂, KL (CNCI). **Waterloo**: Hespeler, 18 June 1962, ♂, KL (CNCI). **Wentworth**: Ancaster, 24 June 1955, ♂, O. Peck (CNCI); Stoney Creek, 12 July 1980, ♀, R. Thomson; Dundas, 11 June 1980, 5♂, C. Bolter; Spencer Gorge, 18 August 1993, ♀; Hamilton, 3 July 1979, ♂, S. Beierl; 27 June 1980, ♂, S. Beierl (DEBU). **Lincoln**: Jordan, ♂; Vineland, 7 June 1979, ♂, BL; 14 June 1977, 2♀, BR; Grimsby, 19 June 1979, ♀, BL; 21 June 1978, ♂,

M. Lichtenberg; 19 June 1978, ♀, BL; 14 June 1977, ♀, AT (DEBU). **Welland**: Thorold, 1 July 1984, 3♀, Gilberg (DEBU). **Brant**: Brantford, 24 August 2001, ♂ PA (DEBU). **Haldimand**: Dunnville, 3 August 1962, ♂, KL; Peacock Point, 3 September 1954, ♂, C. Miller; Dunn Twp, 9 August 1990, ♀ (CNCI). **Middlesex**: Komoka, Feed Mill Prairie, 27 July–13 August 2001, ♂, PA (DEBU). **Elgin**: St. Thomas, 19 July 1955, ♂ (CNCI); Orwell, 14 June 1978, ♂, M. Lichtenberg (DEBU). **Norfolk**: St. Williams, 27 May–3 June 2000, 7♂, BK; 7 September 2001, ♀, BK; Delhi-Simcoe Railway, 27 July 2001, ♂, PA (DEBU). **Kent**: Rondeau Park, 21 June 1977, 2♂, 2♀, D. Maddison (ROME); 10 July 1960, ♂, CL; Chatham, 23 August 1913, ♂, SL; Bothwell, 4 July 1962, ♂, CL (CNCI). **Essex**: Point Pelee, 31 July 1960, 2♂, ♀, KN; 30 June 1920, ♂, BG (ROME); 1 June 1982, ♂, C. Hare; 13 June 1979, ♂, D. Morris; Windsor, Ojibway Prairie, 5 June–3 July 2001, 3♀, PA (DEBU); Kingsville, 23 May 1962, ♂, KL (CNCI); 8 July 1977, ♀, Innes; 8 June–8 July 1977, 2♂, 4♀, BR; 8 July 1977, 5♀, AR (DEBU); Leamington, 19 August 1983, 11♂, 11♀, GL; 4-7 August 1985, 10♂, 10♀, GL; Weatley, 15 August 1982, ♂, ♀, GL; 19 August 1987, 2♀, GL (EDUM). **Ontario**: Port Perry, 1 August 1934, ♀, F. Urguhart (ROME). **Locality unknown**: Lake Superior, 29 June 1961, ♀, KN, *Rubus* (ROME). Figure 6.
Localities other than Ontario: Alaska, North West Territories, British Colombia, Saskatchewan, Manitoba, Québec, New Brunswick, Nova Scotia (CNCI, DEBU, ROME).

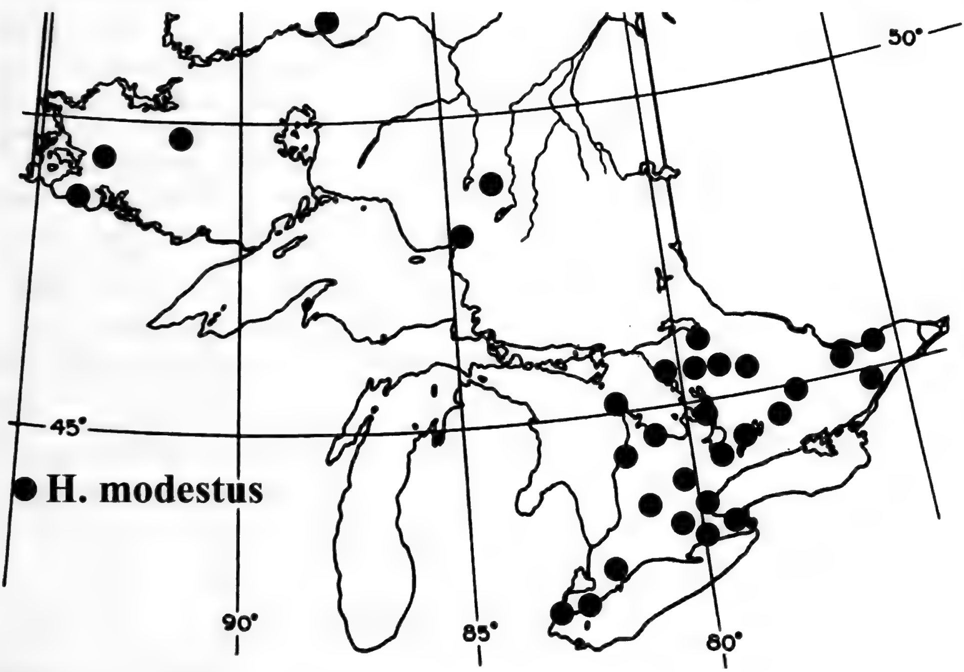

FIGURE 6. Ontario collection localities of *Hylaeus modestus*.

9. *H. nelumbonis Robertson
Norfolk: Long Point, 199?, 7♀, ♂ (Dr. L. Packer's Collection). Figure 4.
Localities other than Ontario: **UNITED STATES, Ohio:** Put-in-Bay, S. Bass Isl., 11 July

1920, ♀, ♂, C. H. Kennedy Coll. (UCRC); North Carolina: Wenona, 27 May 1925, ♀, T. B. Mitchell (NCSU). **Louisiana:** opp Orange, Sabine R. Ferry, 20 June 1917, ♂ (NCSU); New Orleans, 13 March 1955, ♀, ♂, R. R. Dreisbach [Homotype: *Prosopis nelumbonis* Robertson].

10. *H. rudbeckiae* (Cockerell & Casad)
UNITED STATES, California: Riverside, 2 September 1935, ♀, Timberlake Coll. (UCRC)

11. *H. saniculae* (Robertson)
UNITED STATES, Tennessee: Gatlinburg, Sm. Mt. N. P., 25 June 1947, ♂, T. B. Mitchell [Homotype: *Prosopis saniculae* Robertson] (NCSU). **Michigan:** Mecosta Co., 25 July 1951, ♀, R. R. Dreisbach (NCSU); Alcona Co., 27 July 1946, ♀, R. R. Dreisbach (NCSU).

12. *H. sparsus* (Cresson)
UNITED STATES, North Carolina: Mt. Pisgah, 23 June 1934, 2♀, T. B. Mitchell (Homotype: *Prosopis thaspii* Robertson; Homotype: *Prosopis sparsa* Cresson] (NCSU).

13. *H. verticalis* (Cresson)
Kenora: Black Sturgeon Lake, 4-8 July 1962, ♂ and 81♀; Oneside Lake, 2 June 1960, ♂, CL (CNCI). **Sudbury**: Chapleau, Racine Lake, ♂, US (DEBU). **Carleton**: Ottawa, 3 June 1986, ♂, H. Goulet; 11-20 June 1913, 9♂, SL (CNCI); 18-20 June 1913, ♂, ♀, SL; 7 June 1914, ♀, SL (EDUM). **Hastings**: Trenton, 31 May 1896, ♂, Evans (DEBU). **Haliburton**: Minden, 11 September 1957, ♀, McMullen; Algonquin Park, 22 August 1993, ♀, C. Jons (DEBU). **Northumberland:** Hastings, 1895, ♂, Evans; Alderville, First Nations Prairie, 1 September 2001, ♀, PA (DEBU). **Prince Edward:** Picton, Smith Bay [Smith's Bay], 1 July 1970, ♂, J. MacAlpine (CNCI). **Bruce**: Dyers Bay, 19 July–19 August 1953, 5♀, PG (DEBU); Bruce Peninsula, 10 July 1960, ♀ (ROME). **Peel**: Caledon East, 28 June 1980, ♂, C. Beierl (DEBU). **Wellington**: Bellwood, 13 July 1965, ♀, ED; Arkell, 2 June 1952, ♂, PG; Guelph, 10 August 1951, ♀, PG (DEBU). **Halton:** Halton Lake, 2001, RM (ROME), from nests in wood, 3♂. **Lincoln:** Jordan, 21 June 1919, ♂, C. Cunra (CNCI). **Essex**: Leamington, 4 August 1985, ♀, GL (EDUM); Windsor, Ojibway Prairie, 31 July–3 August 2001, ♂, PA (DEBU). **Locality unknown:** Ontario, 26 June 1886, ♂ (DEBU). Figure 6.
Localities other than Ontario: British Columbia, Alberta, Saskatchewan, Manitoba, Québec, New Foundland (CNCI).

Acknowledgments

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2006 ANNUAL MEETING

The **143rd Annual Meeting** of the **Entomological Society of Ontario** took place from October 27th to the 29th, 2006 with the theme "The Many Facets of Entomology". As is becoming usual, there was an impressive number of students at the conference, as well as professional entomologists from around the province. Plenary talks at the meeting were delivered by Sander Koenraadt (Cornell University), Roger Quinn (Case Western Reserve University), and Elizabeth Tibbetts (University of Michigan). Additional highlights included several awards and expressions of appreciation. Dr. Glenn Wiggins became a new Fellow of the ESO. Richly deserved service awards were presented to several individuals whose work has contributed to 'the many facets of entomology" in Ontario: Yves Prévost (former Editor of JESO), David Pree (formerly a JESO Associate Editor), and Dana Gagnier (former Editor of the ESO newsletter). Last but not least, President's Prize Awards awards for outstanding student presentations were made to Amy Sharp (Brock University) and Hien Ngo (York University). The conference was supported by generous contributions from the University of Guelph, Wings of Paradise Butterfly Conservatory, Firefly Books, BASF, Bayer CropScience, Engage Agro, Syngenta Seeds, NK Seeds (Syngenta), Pioneer DuPont, MGS Horticultural Inc., and Laresco. Further details of the 2006 Annual Meeting can be found in the Autumn 2006 issue of the ESO Newsletter, available on the ESO website.

ENTOMOLOGICAL SOCIETY OF ONTARIO

The **Society** founded in 1863, is the second oldest Entomological Society in North America and among the nine oldest, existing entomological societies in the world. It serves as an association of persons interested in entomology and is dedicated to the furtherance of the science by holding meetings and publication of the **Journal of the Entomological Society of Ontario**. The **Journal** publishes fully refereed scientific papers, and has a world-wide circulation. The Society headquarters are at the University of Guelph. The **Society's library** is housed in the McLaughlin Library of the University and is available to all members.

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FELLOWS OF THE ENTOMOLOCIAL SOCIETY OF ONTARIO

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